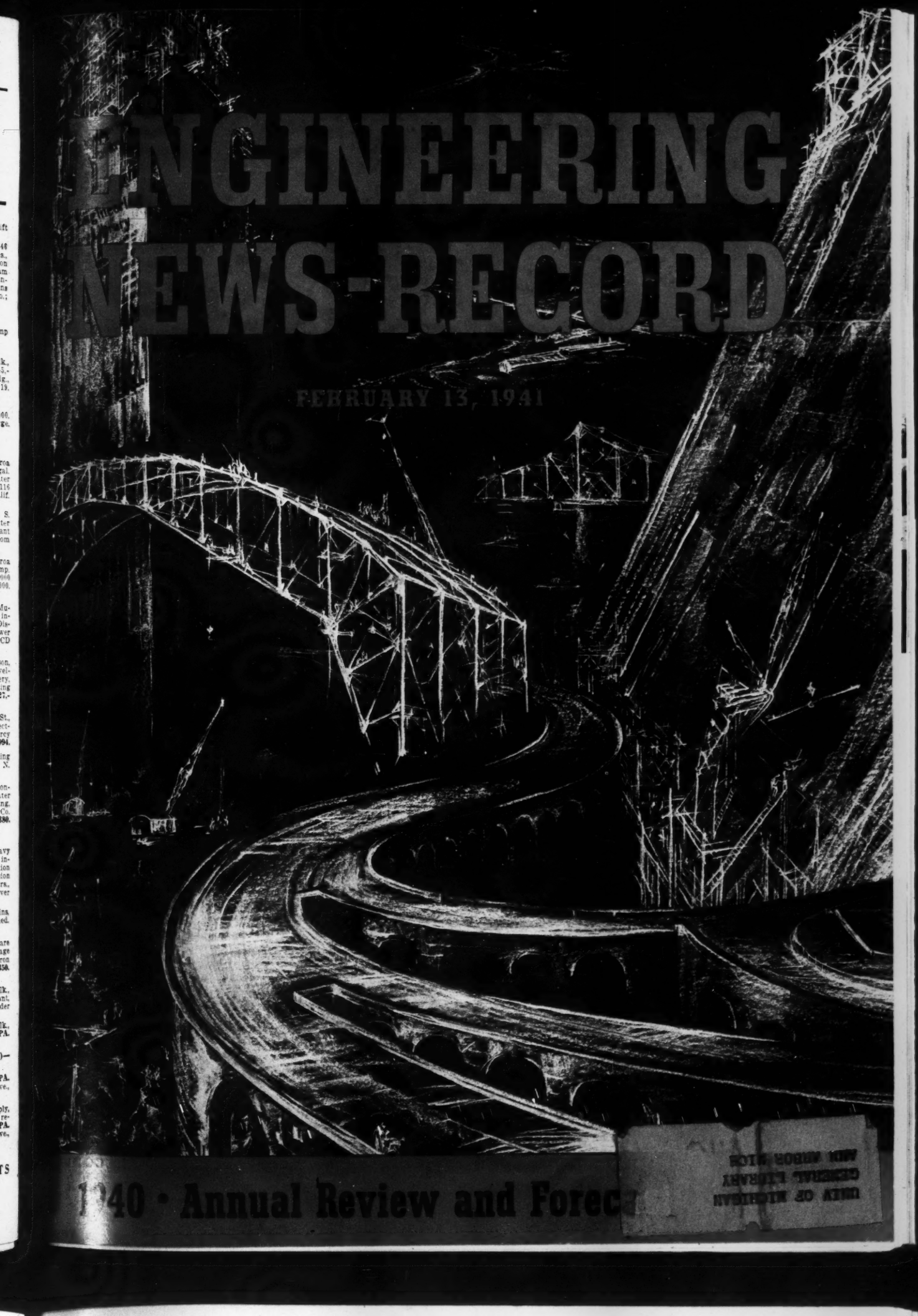


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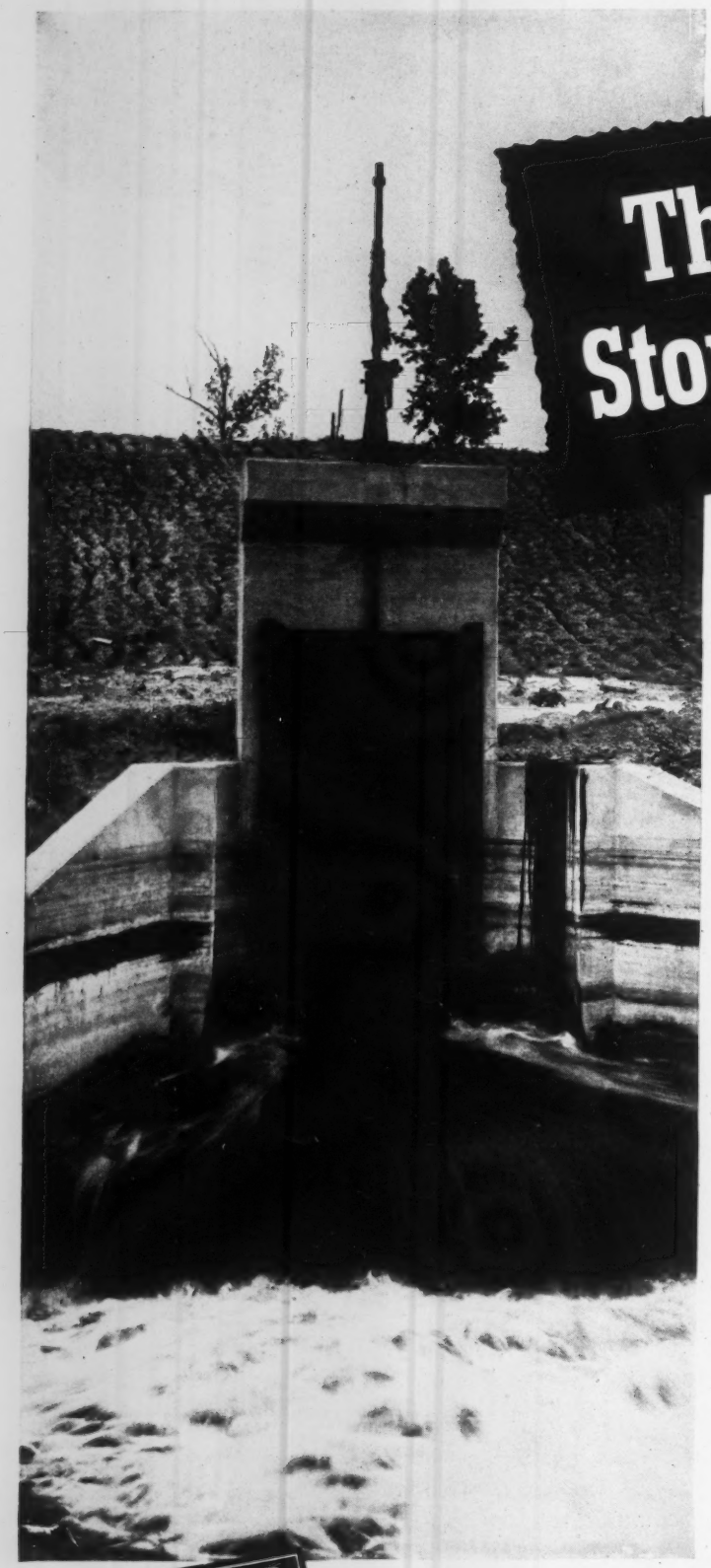

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**WALDO G. BOWMAN, *Editor*** • **ALBERT E. PAXTON, *Manager***

Vol. 126 | FEBRUARY 13, 1941 | No. 7

## THIS WEEK

• Accomplishments and progress of the construction industry during 1940 are reviewed in the major section of this issue. The review provides an appraisal of the past twelve months for the purpose of indicating the trends of engineering thinking and construction procedure which will be characteristics of the industry during 1941.

• Following the news section, and the editorial pages summarizing 1940 activity, a group of statements is presented by members of the editorial staff, with the aid of many of our readers, covering special fields of engineering and construction activity.

• A feature of the issue is the section reviewing progress on the major projects which were in an active construction stage during 1940. An insert contains concise information on the important projects relating to national defense. Of particular value is the statistical review of construction which assembles and analyzes the figures of volume and costs as a means of establishing the trends which will affect the industry in 1941.

## THINGS TO COME

• Erection methods on the 10,000-ft. Ludlow Ferry Bridge over the Potomac River are described in an article which covers the unusual procedure for cantilever steel placing.

• A housing project for the expanded forces at the Norfolk Navy Yard typifies the design and construction of Navy Department low-cost housing projects.

• Troop concentration at Fort Bragg, N. C., has created serious municipal problems for the nearby town of Fayetteville, and expansion of the town's public works facilities is described.

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# The Week In Engineering and Construction



## More money for defense housing

***New public housing program of $156,750,000 needed. More liberal FHA aid also sought.***

Housing Coordinator C. F. Palmer last week asked Congress to appropriate an additional $156,750,000 for more publicly owned defense housing and also to authorize FHA financing of private houses in defense areas without a down payment. The new money would bring the total of government-owned defense housing to nearly $500,000,000.

Of the appropriation asked for more public defense housing, $150,000,000 would go to increase the present federal construction of temporary or permanent houses. The remaining $6,750,000 is to be used to initiate a new program of "mobile housing" which can be moved temporarily into areas where an emergency exists. For housing families, about 3,000 trailers are to be bought at a cost of about $1,000 apiece. These could be towed or shipped into an area where they are needed, the running gear removed (since there is a shortage of axles), and be blocked up until it is time to move them somewhere else. Another aspect of this same program involves purchase and rehabilitation of obsolete passenger ships —such as the Hudson River Night Line boats—to be used as floating dormitories for single men.

#### *FHA liberalization proposed*

The proposed legislation would permit house-builders to obtain FHA-insured mortgages up to 90 per cent of the sales value of their houses. At present, 90-per cent mortgages are only available to owner-occupants who put up a 10-per cent cash payment. Effect of the new law would of course be that a speculative builder would not need to put up any money of his own but would merely have all or part of his profit tied up in the job. The builder could rent the houses if he wished or could sell them. He would not be required to collect any down payment from the buyer; the assumption is that he would collect the down payment over a period of years.

These liberal terms would only be available for houses in areas designated as in need of defense housing. Cost of single houses would be limited to $4,000, and cost of apartment buildings could run up to $10,500 for a four-family building. For the present, not more than $100,000,000 in mortgages could be insured on this basis, but if the plan works out well it is probable that this limit will be raised or removed.

Since a comparatively high default rate is to be expected on this type of mortgage, the plan provides that RFC contribute $10,000,000 to the FHA insurance fund. The regular insurance premiums would be charged on the loans. If the armament program stops, FHA will doubtless take a heavy loss on these loans, but Palmer points out whatever part of the program does not default will represent a saving of money that would otherwise have had to be spent for government housing.

## Cantonment construction approaches peak

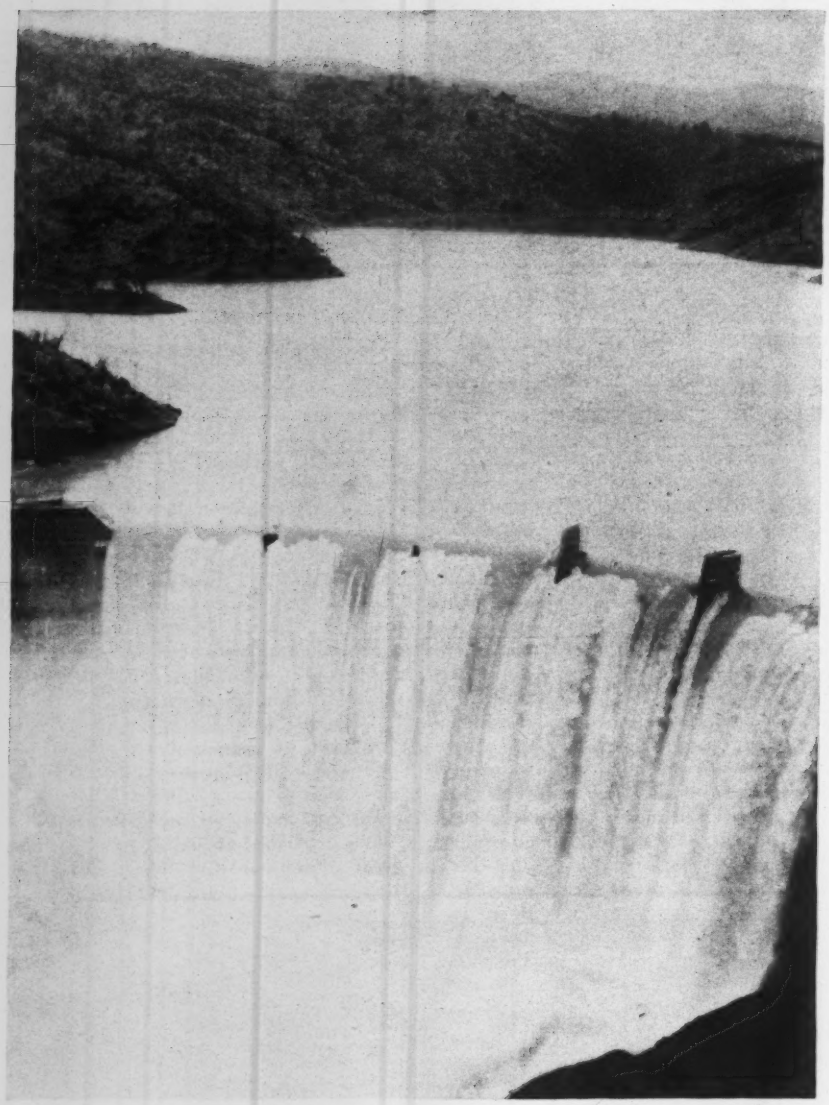
The cantonment construction program is approaching its peak of activity and will start to fall off sharply at the end of April; engineers on many projects are starting to lay off men, and most of the actual construction will be finished by June. A new cantonment program this summer appears quite likely, however. It is generally expected in Washington that the War Department will soon ask Congress for a 2,000,000-man army—perhaps within the next few weeks, perhaps when it completes drafting of its 1,400,000-man army. This would necessitate cantonments for an additional 600,000 men, as compared with the present program which involves construction of barracks for about 1,100,000 men.

In anticipation of such an eventuality, defense officials are recommending to the War Department that it acquire a stock-

Photo by Kenneth S. Brown

## Concrete sawtooths furnish a rare scene

*Sawtooth roofs of reinforced concrete are not common, since the one-story factory buildings requiring such roofs are usually of steel. But at the Boeing Aircraft Co. plant in Seattle a four-story engineering building of concrete required roof light for a drafting room, and sawtooths were the logical choice. In keeping with the rush character of the rest of this plant expansion job, concrete buggies were swarming over the roof shortly after this picture was taken. The entire plant covers 42 acres in a building a quarter of a mile long and one-fifth of a mile wide. It is an Austin Co. job.*



## First water goes over Upper Narrows Dam in California

*First water over the Upper Narrows Dam, recently completed on the Yuba River, near Marysville, Calif., was a 55,000-sec.ft. flood that submerged the spillway 7 ft. on Dec. 27, 1940. This project was developed to store mining debris, and was designed to overpour with the record fall of 240 ft. Concreting of crest piers was completed Jan. 11, 1941.*

*The structure was built by the U. S. Engineer Department and contract was carried out by L. E. Dixon, Los Angeles, and the Arundel Corporation, Marysville, Calif.*

pile of some half billion board feet of lumber. If another program is put through it will then be possible to order the lumber in time.

Extent to which current construction activity is dependent on the cantonment work is well illustrated by the December employment figures. Of an average weekly employment on defense construction of 318,000, some 221,000 consisted of men working on cantonments. Another 34,000 were working on aviation facilities, about 14,000 on factories and shops, 9,000 on shipyard facilities, and 7,000 on housing projects.

## Attempt to stop work on Denison Dam fails

An attempt by Oklahoma's Governor Leon Phillips to halt further construction of the $54,000,000 Denison Dam, was repulsed recently when a 3-judge Federal Court sitting at Muskogee, Okla., sustained a motion of the Federal Government to dismiss his injunction suit. The governor had contended that building the dam across Red River at the Oklahoma-Texas boundary was an invasion of the sovereign rights of the state. It is an Army engineer project.

## Indiana plans 20-year highway program

A comprehensive study of Indiana's present highway system, with recommendations for improvement of the system to meet anticipated traffic needs over a 20-year period, has been completed by the Indiana State Highway Commission under the direction of James D. Adams, chairman.

While the report does not attempt to outline specific construction projects as necessary to develop a state highway system adequate for an anticipated 87 per cent increase in the vehicular mileage traveled on the system, it does list roads, bridges and grade separations which are considered deficient in one or more of the standards on which the survey is based.

It is estimated that a sufficient number of projects are listed as advisable in the modernization of the state highway system, to employ all construction funds which the commission will have available for the next five years. For the purpose of the survey arbitrary standards for minimum right-of-way width, width of bridge roadways and width of pavement were established.

• • •

## Mayors urge federal civil defense board

Creation of a federal civil defense board to integrate plans to protect cities and towns against air attack and to coordinate all civil defense activities with military effort has been recommended to President Roosevelt by the U. S. Conference of Mayors.

New York's mayor, F. H. LaGuardia, president of the Mayors Conference, in a preliminary report to the President, outlined a program which provides the establishment of regional offices, one in each Army corps area, with sub-regional offices within some of the larger corps areas. In each municipality there would be set up a civil defense board under chairmanship of the mayor, but in many instances it might be found, in practice, better to group some municipalities so as to pool their resources. The local boards, in addition to being responsible for working out detailed plans of passive air defense for the areas under their control, decontamination, medical services, clearing of debris, repairing of roads, etc., will also be responsible for estimating the number and kinds of any special equipment as may be required in an emergency. The report states that it is essential that the federal, regional and local boards coordinate their efforts in complete cooperation with military preparations, if the plan is to function properly.

# National professional society meets with Illinois engineers

**Illinois Society of Engineers is host to National Society of Professional Engineers in a meeting at which the broader aspects of engineering work and training are discussed**

The young National Society of Professional Engineers held its sixth annual convention in cooperation with the 56th meeting of the Illinois Society of Engineers at Chicago, Jan. 30-Feb. 1. Nearly 500 engineers registered at the joint sessions and heard more than a score of professional and technical papers, interspersed with business meetings and entertainment. The meeting was divided into drainage, roads and pavements, surveying, water supply and sewerage sections.

Prof. Hale Sutherland, head of the department of civil engineering, Lehigh University, in one of the outstanding talks of the convention, departed from the usual run of engineering addresses and discussed the place of the engineer in the world today. He declared the world is now trying to live by science alone, which, he holds, is impossible, and urged more consideration of human relationships and an integration of scientific principles with theological ideals. Prof. Sutherland urged all schools to give at least as much time to training in character as to training in any major scholastic discipline. The N.S.P.E. passed a resolution endorsing Professor Sutherland's stand to the engineering colleges.

Another excellent talk was given by C. E. Scwob, assistant engineer, Illinois Department of Public Health, who criticized sewage plant design from the operator's standpoint. He declared engineers failed to make sewage plants flexible for variation in operating requirements. Among pet peeves of operators he listed valves located in dirty pits, the necessity for going out into zero weather to operate a valve, the necessity for calking gates from the wet side, the location of plants in areas subject to flooding, lack of screens in windows and doors, lack of suitable washrooms, failure to locate recording instruments under cover in accessible places, failure to provide easy methods for the disposal of screenings, and, above all, failure to provide stop gates that will work.

Dean T. R. Agg, Iowa State College, discussed how coming events affect engineers. Tracing precedents that have shaped the course of human endeavor to establish security for nations and individuals, Dean Agg stated that past attempts have only resulted in transfer of some income from high producers to the low producers without establishing any real security. He outlined an engineering approach to the problem based on five steps: (1) Recognition that production is the basis of security; (2) educational programs in the public schools to prepare for production; (3) elimination of customs, laws, governmental and industrial policies that hamper the individual in producing goods and services; (4) realization that perhaps 5 percent or more of the population is incapable of producing its own subsistence; (5) a concerted attack by production engineers on devising methods of utilizing persons of low-producing capacity in such a way that they can achieve at least a decent subsistence standard of living.

### New officer rosters

The National Society of Professional Engineers elected J. W. Beretta, San Antonio, Texas, as president for the coming year. New vice-presidents are: H. J. Darcey, Oklahoma City, Okla.; A. L. Lynch, Hartford, Conn.; S. I. Sacks, Philadelphia; and D. H. Walker, Ft. Wayne, Ind. W. L. Simpson, Washington, D. C., is treasurer. Edward Larson is secretary, located at the national headquarters in Washington. The next annual meeting will be held in April, 1942, at Atlantic City, N. J.

New officers of the Illinois Society of Engineers are: President, D. C. McCurdy, Belleville; vice-president, Alex Van Praag, Decatur; directors, J. H. Morgan, Urbana, and C. J. McLean, Dixon. Prof. H. E. Babbitt, Urbana, was re-elected secretary-treasurer. The society conferred honorary membership upon L. K. Sherman, consulting engineer, Chicago; M. L. Greeley, president of Greeley, Howard & Norlin Co., surveyors, Chicago; and Professor Babbitt. The 1942 meeting will be held at East St. Louis.

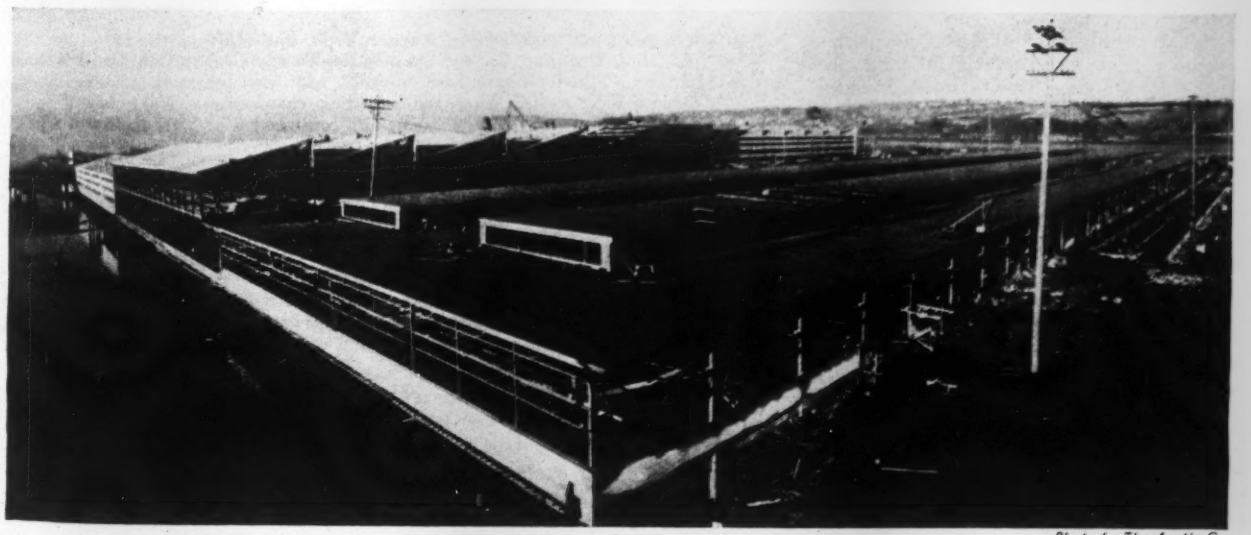


Photo by The Austin Co.

## No lag in progress here

*Contradicting the too frequent stories of lack of speed on defense construction is this new plant for manufacturing 4-engine Boeing bombers in Seattle. Increased from 166,000 sq. ft. to 832,000 sq. ft. in a period of ninety days ending last October 1, the plant will cover a total of 42 acres or 1,900,000 sq. ft. by March. All of this area is under continuous roof. It forms a single building 1/4 mi. long and 1/5 mi. wide. The Austin Co. is working 1,400 men two shifts, day and night, to bring the present addition of over a million square feet to completion.*

## Cherokee Dam schedule advanced three months

Indications now are that TVA's Cherokee Dam, which is being rushed to completion to provide power needed for aluminum production, will be completed in seventeen months instead of the twenty months originally expected. Construction of the dam will probably be finished by January of next year, Theodore B. Parker, TVA chief engineer, told a Congressional committee. First generating units, on the new schedule, can be installed in May or June instead of August as first anticipated.

At present, TVA officials told *Engineering News Record*, the work is about a month ahead of schedule. Placing of the 750,000 yd. of concrete in the main dam structure, scheduled to start Feb. 1, actually got underway a month earlier, and some 4,000 yd. are now in place. Roughly 1,000,000 of the 3,000,000 yd. of earth and rockfill is placed—so far advanced that earthfilling operations are to be stopped for the next three months.

Much of the credit for this speed-up of a schedule, which was originally so fast that much doubt was expressed whether it could be maintained, is given to the unusually favorable weather. Another major point, TVA says, is the authority granted by Congress to negotiate contracts, which has permitted quick procurement of materials and equipment. TVA is doing the work with its own forces.

• • •

## Wage scale adjusted to living costs at Seattle

The Seattle Construction Council has entered into an agreement with the Seattle Building Trades Council which includes a provision for balancing of wages and living costs. The plan calls for use of the department of labor's national index on the cost of living, based on 198 items including commodities, services and rents of the average workman in the United States; for instance, if the index of Sept. 15, 1941, should be five points or more higher than the level of Sept. 15, 1940, there will be a corresponding increase in wages. Adjustment will be made upward or downward based on an average wage of $1.30. Should the scale drop below or down to those existing as of January 1, 1940, then the decrease shall cease to be automatic and the contract shall be thrown open for negotiations for downward revision.

This method is subject to review by written notice 90 days prior to Jan. 1, 1943. It is understood that all construction falling within this agreement contracted prior to Nov. 1 of any year, under this method of negotiation, shall be completed under the existing scale.

# JOBS OF THE WEEK

***DEFENSE HOUSING PROJECT, Hartford, Conn.***
Cauldwell Wingate Co., New York, N. Y., has been awarded contract for constructing 1,000 dwelling units including 236 buildings, community buildings, and boiler plant for Hartford Housing Authority, at an estimated cost of $3,597,000.

***AIRPLANE FACTORY, Columbus, O.***
Curtiss-Wright, Port Columbus, has awarded masonry and excavation contract for airplane factory, to Darin Armstrong Co., Inc., Detroit, Mich. Total cost of project $10,000,000.

***HOUSING PROJECT, Audubon, N. J.***
Wheeler Engineering Co., New York, N. Y., has received contract for constructing housing for civilian employees at shipyard for Public Buildings Administration, Washington, D. C., at a cost of $1,400,000.

***AMMUNITION STORAGE DEPOT, Ravenna, O.***
Hunkin-Conkey Construction Co., Cleveland, O., has contract to construct an ammunition storage depot, including 300 reinforced concrete igloo type underground structures. Estimated cost $4,000,000. Atlas Powder Co., will operate.

***SHIPYARD, Portland, Me.***
Sanders Engineering Co., Portland, Me., received contract to construct a 55x450 ft. three basin ways, various shop and warehouse buildings for Todd Shipyard Corp. of New York, N. Y. Estimated cost $3,000,000.

***AIRCRAFT GEAR PLANT, Fort Wayne, Ind.***
Mississippi Valley Structural Steel Co., Melrose Park, Ill., has been awarded contract for furnishing and erecting structural steel for 1 story, 282x722 ft. aircraft engine gear plant by Studebaker Corp., of South Bend, Ind. Total estimated cost $4,000,000.

***AIRPLANE ENGINE PLANT, Chicago, Ill.***
Joseph T. Ryerson & Son, Chicago, Ill., has contract for furnishing and erecting structural steel for 560x1,000 ft. airplane engine parts plant by Studebaker Corp., South Bend, Ind. Estimated cost $20,000,000.

***PLANT, South Bend, Ind.***
R. C. Mahon Co., Detroit, Mich., received contract for erecting and furnishing structural steel for 760x1,040 ft. aircraft engine plant, for Studebaker Corp., South Bend. Total estimated cost $12,000,000.

***SHIPYARD, Wilmington, N. C.***
Loftis, Orrell and Underwood—V. P. Loftis Construction Co., Charlotte, N. C., U. A. Underwood, Inc., and J. D. Orrell, Wilmington, N. C.—received a $900,000 contract for clearing site, excavation of ways, and administrative buildings for North Carolina Shipbuilding Co., Wilmington, N. C. Estimated total cost of project $5,000,000.

***HOUSING and DREDGING, Pearl Harbor, T. H. and Midway Island***
Hawaiian Dredging Co. and Associates—Turner Construction Co. and Raymond Concrete Pile Co.—have been awarded additional work on contract from Navy Department for deepening and widening channel into Wake Island for Naval air station, at a cost of $2,000,000; also construction of 1,000 family dwelling units and facilities at Pearl Harbor to cost $3,500,000.

***ORDNANCE DEPOT, Umatilla, Ore.***
J. A. Terteling & Sons, Boise, Idaho, has contract from War Department to construct an ordnance depot. Estimated cost $7,500,000.

***ARMY GARRISON FACILITIES, Alaska***
Siems-Spokane Co., Seattle, Wash., and Associates—Johnson, Drake & Piper, Inc., and Puget Sound Bridge & Dredging Co.—have been awarded additional work on contract from Navy Department for constructing facilities for army garrisons at Sitka, Kodiak and Unalaska. Ustimated cost is $5,193,840.

***HOUSING, Fort Bragg, N. C.***
George W. Kane, of Durham, N. C., has been awarded contract to construct 500 housing units for defense project by Constructing Quartermaster. Estimated cost $1,543,000.

***BONNEVILLE DAM, TURBINES, Bonneville, Ore.***
S. Morgan Smith, York, Pa., has received contract for constructing turbines for Bonneville Dam, by Bureau of Reclamation, Denver, Colo., at a cost of $2,689,100.

***AIRPORT BUILDINGS, San Bruno, Calif.***
Barrett & Hilp, of San Francisco, Calif., was lowest bidder for constructing main hangar, administration building, gasoline pumphouse, and engine test building at Mills Field, San Francisco airport for the city and county of San Francisco at $829,581. Bids were opened February 4.

NOTE—Additional bidding and contract news on over 800 projects large and small appear in the Construction News section beginning on page 192.

## WASHINGTON HIGHLIGHTS

IN SPITE of considerable pressure on the supply of structural steel, defense officials are of opinion that an adequate supply can be maintained without application of priorities if the steel mills maintain careful scheduling of deliveries. So far no priorities have been applied to steel, but a committee representing the steel industry, industrial consumers, the Army, and the Navy have been named to advise the priorities division of the Office of Production Management whether priorities are necessary.

WHAT SOME people feel about the way the defense program is being handled is summed up in the true story of the construction man who came to Washington looking for a contract. He spent several weeks here, saw lots of officials, was sent from one office to another; he finally decided he was getting a run-around and went home. A few weeks later he received a letter from the Quartermaster Corps. It told him rather sharply that he was behind schedule on his contract and expressed the hope he would soon have his job up to date.

METHODS OF CONSTRUCTION to protect civilian populations against bombardment will be outlined in a manual to be issued by the Defense Commission within a few weeks. Prepared by the Corps of Engineers, partly on the basis of experiment and partly from British studies, it will deal with such matters as the resistance of structures to bombardment, design of shelters, and the like.

AN INFORMATION center for business men coming to Washington has been established by the Department of Commerce. The staff will try to route people to the proper official, not necessarily in Commerce Department, to deal with their particular problem. The information center is located in room 1060 of the Commerce Building.

THE WORK STOPPAGE last week on Continental Divide Tunnel of the Colorado-Big Thompson reclamation project only lasted three or four days, and the men are now back to work. Operating engineers stopped working on the first section of the tunnel in protest against the rates the Department of Labor had established to be paid on the second section, on which contracts are soon to be awarded. Work was resumed when the contractor on the present section agreed to pay higher than the minimum scale if he gets the second section.

## Civilians named for new Army zone setup

In keeping with the plan to decentralize the Quartermaster Corps' construction division in nine zones, with each zone having an engineering, an operations and an administration departments headed by civilians, the Army this week appointed 29 civilians for the work. Those appointed and where they will be located along with the zone constructing quartermaster are as follows:

Zone 1—Boston, Mass.
Constructing Quartermaster—Maj. R. G. Richards
Engineer—W. G. Grove, Hartford
Architect—Henry R. Shepley, Boston
Operations—Peter F. Connolly, New York

Zone 2—New York, N. Y.
Constructing Quartermaster—Lt. Col. M. A. MacFadden
Engineer—Enoch R. Needles, New York
Architect—Robert B. O'Connor, New York
Operations—H. M. Hale, New York

Zone 3—Baltimore, Md.
Constructing Quartermaster—Maj. J. H. Burgheim
Engineer—Charles H. Stevens, Philadelphia
Architect—Louis McLane Fisher, Baltimore
Operations—E. C. Macy, Philadelphia

Zone 4—Atlanta, Ga.
Constructing Quartermaster—Col. H. L. Green
Engineer—Edward S. Bres, New Orleans
Architect—J. W. Humphrey, Atlanta
Operations—E. O. Korsmo, Memphis

Zone 5—Columbus, Ohio
Constructing Quartermaster—Maj. B. F. Vandervoort
Engineer—C. P. Fortney, Charleston, W. Va.
Architect—Joseph Lewis Weinburg, Cleveland
Operations—Thomas Bantley, Toledo

Zone 6—Chicago, Ill.
Constructing Quartermaster—Maj. E. C. Hayden
Engineer—Robert Isham Randolph, Riverside, Ill.
Architect—C. Herrick Hammond, Chicago
Operations—To be appointed

Zone 7—Omaha, Neb.
Constructing Quartermaster—Maj. M. E. Townes
Engineer—Harry E. Frech, St. Louis, Mo.
Architect—Eugene S. Klein, St. Louis
Operations—C. R. Conkey, Minneapolis, Minn.

Zone 8—San Antonio, Tex.
Constructing Quartermaster—Lt. Col. E. V. Dunstan
Engineer—Edward N. Noyes, Corpus Christi
Architect—Roy Leibsle, San Antonio
Operations—F. G. Chamberlain, San Antonio

Zone 9—San Francisco, Calif.
Constructing Quartermaster—Lt. Col. E. M. George
Engineer—Harry W. Dennis, Los Angeles
Architect—Timothy L. Pflueger, San Francisco
Operations—E. T. Foley, Pasadena

## Contractors on defense work must pay gas tax

A decision has just been handed down by the Florida Supreme Court which affirms an order of the Duval County court, requiring the Standard Oil Co. to turn over to the state all taxes collected on gasoline sold by it to Duval Engineering & Contracting Co., George D. Auchter Co., and others using the gasoline in the performance of work at the Southeastern Naval Airbase at Jacksonville.

The decision points out that the gasoline was purchased by the contractors themselves and not by the federal government; and that, since the agreement between the government and the contractors was on a cost-plus-basis, costs would include any taxes paid by the contractors in the purchase of supplies and materials. This decision eliminates, at least for the time being, any possibility of contractors being exempt from paying the seven cents per gallon state gasoline tax when used in connection with national defense projects in Florida.

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## Texas primary roads to have 160-ft. right-of-way

The Texas State Highway Department has announced that on new locations for primary roads where a considerable increase of traffic is expected, counties will be required to provide right-of-ways of at least 160 ft. In Texas, rights-of-way are furnished by the counties.

Announcement of the new plan was contained in the 1940 biennial report of the highway department.

# Experience with treated timber recounted at A. W. P. A. meeting

***American Wood-Preservers Association devotes one full day of its 37th annual meeting to the discussion of experience with treated timber in many types of structures.***

An impressive record of the advantages to be gained by the use of treated timber in railway and highway structures and in railroad track was presented during "Users' Day" at the 37th annual meeting of the American Wood-Preservers Association at Louisville, Ky., Feb. 4-6. About 500 members and guests attended the sessions, at which 40 papers and committee reports were presented. Ralph E. Meyers, Galveston, Tex., president of the association presided.

#### Experience records

L. L. Adams, engineer maintenance of way, Louisville & Nashville R. R., discussed the use of treated ties, creosoted piles and treated timber for bridges and various other purposes dating back over a period covering more than 65 years. A. N. Williams, president, Lehigh Valley R. R., told of the experiences of his railroad with treated bridge, switch, and crossties over a period of 31 years, pointing out especially the savings made in the use of treated timber.

A. M. Korsmo, principal structural engineer of the U. S. Housing Authority, spoke of "The Place of Treated Timber in the U. S. Housing Authority Program." He stated that the authority was created to lend federal assistance in the construction of safe and sanitary housing for families of low income, that definite cost limitations are prescribed by legislation, and that only by continued effort to investigate new and better materials and methods of construction has it been possible to provide durable houses in greater number for less money. Permanence, he stated, must be achieved economically, and pointed out that in many regions unfavorable conditions for the use of untreated wood prevail. He recommends the use of treated lumber for first-floor construction, including wall plates, joists, bridging and rough flooring. He discussed at some length the use of creosoted foundation piles which in many instances have been found to be very economical for structures resting on soil with low bearing capacity. Too frequently, he pointed out, local building codes place ultraconservative limits on the bearing power of foundation piles and prevent their economical use. The USHA recommended wood piles as an alternate to concrete and other types, permitting design loads of 30 tons on timber piles driven in suitable soils.

J. B. Broach, bridge construction engineer with the North Carolina State Highway and Public Works Commission, described his experience with treated lumber, principally in highway bridge work during the past 20 years. Some of the unsatisfactory results obtained in the early years of his department were pointed out and he analyzed the remedial steps taken to obtain satisfactory treated timber construction. Mr. Broach pointed out that quite as much responsibility devolves upon the engineer in securing satisfactory materials and construction when treated timber is specified as when any other principal construction materials are used.

#### Bridge standards revised

G. A. Haggander, assistant chief engineer, Chicago, Burlington & Quincy R. R., described how that railway system had revised bridge standards to reduce the framing of creosoted timber and various changes in design which minimize the framing and develop better bearing of the stringers. In closing, Mr. Haggander stressed again the desirability of considering treated timber as a separate material for construction purposes, the same as structural steel or reinforced concrete, and stated that it should not be put into the same classification as untreated timber.

W. R. Goodwin, engineer of wood preservation of the Minneapolis, St. Paul & Sault Ste. Marie Ry., Minneapolis, Minn., was elected president. The next meeting will be held in Minneapolis in January 1942. P. R. Hicks, Chicago, is secretary-manager of the association.

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## One way streets for Milwaukee proposed

Milwaukee is toying with the idea of establishing 41 mi. of one-way streets, to and through the business district. The mayor of Milwaukee some time ago named a citizens traffic committee from which a subcommittee on arterials was formed. Here the one-way proposal was developed. Some rerouting of street cars and buses and changing of traffic signs and signals are required by the plan, but aside from these low-cost incidentals not much money is involved. No widening of rights-of-way, cutting off of parkways or even rounding of corners are considered necessary to try out the proposals. Unlike Chicago which long ago drastically restricted parking in the loop, Milwaukee downtown traffic has so few parking restrictions that congestion has become chronic.

In general the proposal is to designate one-way streets in pairs north and south, and east and west in eight one-way street loops and three systems of connecting streets criss-crossing the area bounded roughly by Lake Michigan, 35th St. and Keefe Av. If one minute is saved per trip for each of the 176,000 vehicles in and out of the downtown district an annual saving of $581,000 is estimated to accrue to the motorists. This figure is based on the cost of gasoline, oil and depreciation per minute for vehicles idling along in traffic. The express plan envisages a traffic flow of 30 mph through the downtown area. To accomplish this movement a progressive setting of stop-and-go signals is proposed.

The program is still in the educational stage with advocates of the plan addressing various civic organizations.

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## Penn Turnpike truck tolls reduced

Truck and bus companies using the Pennsylvania Turnpike are now offered a reduction on their monthly bills if tolls aggregate more than $1,000 for a month.

The Turnpike Commission has announced that on bills ranging from $1,000 to $2,000 it will be allowed a 10 per cent discount, while on monthly statements of more than $2,000, 20 percent will be deducted. This cut-rate toll system is to be tried out for three months, users being required to post a $5,000 bond with the Penn Turnpike Commission.

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## Defense housing appropriation asked

(*Continued from p. 73*)

Nearly all of the $282,000,000 available for federal construction of defense homes has now been allocated to definite projects providing about 70,000 dwelling units. About half these units are under contract, and about 1,300 are finished. The Navy is building 17,000 of these and has finished 200. Public Buildings Administration has been assigned 23,250 and has about 10,600 of them under contract. To the U. S. Housing Authority some 17,700 have been assigned, of which 5,200 units are under contract and 1,100 finished. Federal Works Agency, as such, has been allotted 1,650 units and has just put 500 under contract. The Farm Security Administration is to build 1,200 units but has not started work. Neither has Army started its 1,150 units.

In addition, RFC's Defense Homes Corporation is undertaking a $50,000,000 program under which it has placed contracts for about 2,000 units.

## OBITUARY

CHARLES WILLARD DEGINTHER, senior highway bridge engineer of U. S. Department of Public Roads, died at Montgomery, Ala., Feb. 3.

DUNCAN MACVICHIE, 83, mining engineer and railroad builder, died recently at Salt Lake City, Utah.

WILLIAM W. WILLIAMS, founder and former president of the Williams Bridge Co. of Syracuse, N. Y., died at Oswego, N. Y., Jan. 31. Mr. Williams was a graduate of Cornell University, and for many years was civil engineer for the Groton Bridge Co.

FREDERICH BRINSON DOUGLAS, 66, retired civil engineer, died in Los Angeles, Calif., Jan. 27. Mr. Douglas had been associated with the Atchison, Topeka and Santa Fe R.R.

ISADORE FEINSTEIN, resident engineer for the U. S. Public Roads Administration in charge of construction at Peach Springs, Ariz., died Jan. 25 at Prescott, Ariz.

JESSE C. WILLIAMS, 81, retired civil engineer, died at Coalburg, Ohio, Jan. 30. He had been employed by the New York Central R.R.

KAY B. SMITH, 56, civil engineer with the Baltimore & Ohio R.R., died at Willard, Ohio, Jan. 28.

JAMES GURNEY, 82, retired civil engineer, died Jan. 29, at Pana, Ill. Mr. Gurney had been employed by the Baltimore & Ohio R.R.

OTTO C. SPIETH, retired civil engineer, died in Cleveland, Ohio, Jan. 25. Mr. Spieth was formerly with the Baltimore & Ohio R.R. and had worked for the Grasselli Chemical Co.

ROBERT KERSY THOMAS, 52, construction engineer, died Jan. 31, in San Angelo, Tex.

FRED G. CUNNINGHAM, 54, waterworks consulting engineer, died recently at Bridgeport, Conn.

# CONTRACTS AND CAPITAL

ENGINEERING CONSTRUCTION awards for the short week due to the Lincoln's Birthday holiday total $96,346,000, an increase of 151 percent over the corresponding 1940 week. This is the 24th successive week in which current values have exceeded their respective totals of a year ago.

Both public and private construction top the volumes reported for the week last year. Public awards are 214 percent higher, and private construction is up 44 percent.

The current week's volume brings 1941 construction to $774,636,000 for the seven-week period, a 120 percent increase over the corresponding 1940 period. Private awards are 91 percent higher, and public construction, as a result of the 776 percent increase in federal work, is up 138 percent.

In the classified construction groups, gains over the 1940 week are in waterworks, sewerage, bridges, commercial buildings, public buildings, streets and roads, and unclassified; increases over last week are in bridges, public buildings, and unclassified construction.

New capital for construction purposes for the week totals $515,251,000. This compares with $28,630,000 reported for the week last year. The current week's new financing is made up of $315,000,000 in federal appropriations for expansion of shipbuilding yards and ways, $194,000,000 in federal funds for doubling naval ordnance manufacturing facilities, $5,951,000 in state and municipal bond sales, and $300,000 in corporate security issues.

New construction financing for 1941 to date, $616,815,000, tops the volume for the seven-week period last year by 313 percent.

### CONTRACTS

(Thousands of dollars)

| | Week Ending Feb. 15 1940 | Feb. 6 1941 | Feb. 13 1941 |
|---|---|---|---|
| Federal | $2,935 | $23,462 | $61,237 |
| State & Municipal | 21,254 | 23,328 | 14,701 |
| Total public | $24,189 | $46,790 | $75,938 |
| Total private | 14,200 | 46,951 | 20,408 |
| TOTALS | $38,389 | $93,741 | $96,346 |
| Cumulative 1941 (7 weeks) | | | $774,636 |
| 1940 (7 weeks) | | | $350,831 |

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

### NEW PRODUCTIVE CAPITAL

| | Cumulative 1940 7 weeks | 1941 7 weeks |
|---|---|---|
| NON-FEDERAL | $149,274 | $107,815 |
| Corp. Securities | 25,152 | 37,365 |
| State & Mun. | 62,775 | 56,787 |
| U.S.H.A. loans | 60,786 | 12,043 |
| R.F.C. loans | 561 | 1,620 |
| FEDERAL | ..... | 509,000 |
| TOTAL CAPITAL | $149,274 | $616,815 |

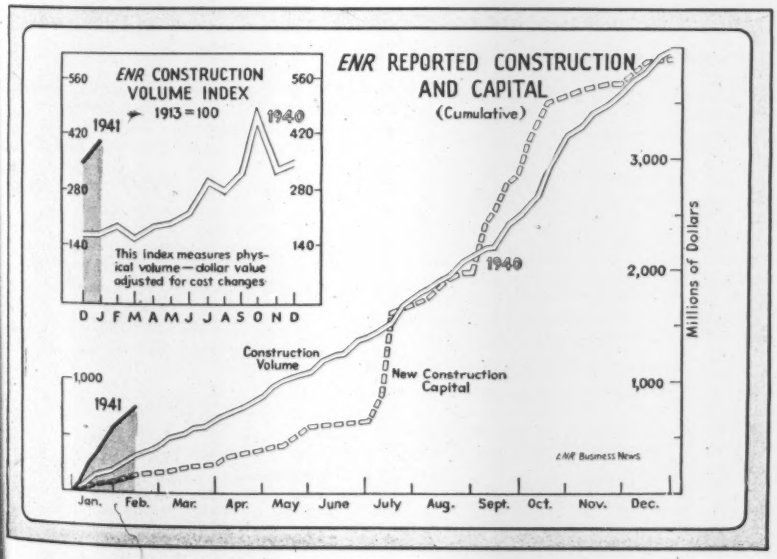
### FHA MORTGAGES

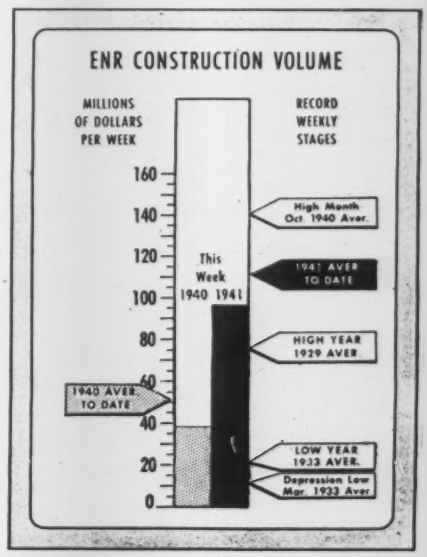
| | Week Ending Feb. 10 1940 | Feb. 1 1941 | Feb. 8 1941 |
|---|---|---|---|
| Selected for appraisal | $19,439 | $21,643 | $22,535* |
| Cumulative 1941 (6 weeks) | | | $117,572* |
| 1940 (6 weeks) | | | $96,547 |

* Subject to revision.

### ENR INDEX NUMBERS

| Index Base=100 | | 1913 | 1926 |
|---|---|---|---|
| Construction Cost | Feb. '41 | 250.50 | 120.42 |
| Building Cost | Feb. '41 | 208.42 | 112.67 |
| Volume | Jan. '41 | 402 | 176 |


ENR CONSTRUCTION VOLUME INDEX
1913=100
1941
1940
This index measures physical volume—dollar value adjusted for cost changes
D J F M A M J J A S O N
ENR REPORTED CONSTRUCTION AND CAPITAL
(Cumulative)
Construction Volume
New Construction Capital
Millions of Dollars
ENR Business News
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


ENR CONSTRUCTION VOLUME
MILLIONS OF DOLLARS PER WEEK
RECORD WEEKLY STAGES
This Week 1940 1941
High Month Oct 1940 Aver.
1941 AVER TO DATE
HIGH YEAR 1929 AVER.
1940 AVER. TO DATE
LOW YEAR 1933 AVER.
Depression Low Mar. 1933 Aver.

# Engineering News Events of 1940

**What happened in 1940 is given in the following chronological summary. Details will be found in the issue of *ENR* of the date noted in parentheses.**

### JANUARY

FEDERAL-AID HIGHWAY PROGRAM of $156,000,000 for the 48 states, the District of Columbia, Hawaii, and Puerto Rico approved by Federal Works Administrator John M. Carmody. *(Jan. 4)*

U. S. COURT OF CLAIMS holds that MWAK, builder of Grand Coulee low dam, is without power to appeal for extra pay according to provisions of a Bureau of Reclamation contract. The firm, a syndicate made up of Silas Mason Co., Walsh Construction Co., and Atkinson-Kier Co., had asked for $5,260,000 as an extra. *(Jan. 18)*

SAMUEL R. ROSOFF, LTD., with Fred Stiefel, chief engineer, claims world's tunneling record as 1,718 ft. of 18-ft. rock tunnel is driven in month of December from Shaft 3 of the Delaware Aqueduct. *(Jan. 18)*

FIRST TUNNEL holed through Jan. 22 for the $70,000,000 Pennsylvania Turnpike as Mason & Hanger workers break through Ray's Hill. *(Feb. 1)*

### FEBRUARY

AMERICAN ROAD BUILDERS' 1940 road show claims a $5,000,000 exhibit of construction machinery at Chicago. *(Feb. 1)*

LAST CONCRETE is placed for Ross Dam on the Skagit River in Washington. *(Feb. 1)*

SEVERE WINTER results in $2,000,000 to $2,500,000 damage to roads of six southern states, according to *ENR* survey. *(Feb. 15)*

ADVANCING 3,100 ft. with two headings in 31 consecutive working days, Walsh Const. Co. sets a new world's record in tunnel driving on Delaware Aqueduct. *(Feb. 22)*

SUPERHIGHWAY financing method for Chicago and Cook County held unconstitutional by Illinois Supreme Court. *(Feb. 29)*

SACRAMENTO RIVER VALLEY experiences greatest flood as 8 in. of precipitation in 24 hr. is reported at several points. Extensive damage to contractors' plant and bridges at Shasta Dam. Total damage in valley estimated at $10,000,000. *(March 7)*

### MARCH

COLLECTION of a 10-cent toll on the Hutchinson River Parkway in Westchester County, N. Y., is voided by the New York State Court of Appeals. *(March 7)*

RECORD LOW BID of 90c. per barrel for cement on the West Coast is received as bids are opened for 1,500,000 bbl. of low-heat cement for California Central Valley project. *(March 21)*

GIRDERS 260 ft. long and weighing 198 tons erected in Thomas A. Edison Bridge over the Raritan River at Perth Amboy, N. J. *(March 21)*

PLAN for a strong national organization of sewage works associations receives enthusiastic endorsement at silver anniversary meeting of New Jersey Sewage Works Association. *(March 28)*

EXCAVATION started for $9,000,000 Bureau of Reclamation Friant Dam on the San Joaquin River in California. *(March 28)*

CIO ENTERS heavy construction field as three Pennsylvania highway contractors sign contracts with Construction Workers Organizing Committee. *(March 28)*

### APRIL

HOLING THROUGH of the Allegheny Mountain tunnel on the Penn Turnpike April 2 marks completion of major rock work for the 160-mile superhighway. *(April 11)*

HIGHWAY TRANSPORTATION as a whole is not subsidized but paying its own way, according to Federal Coordinator of Transportation Joseph B. Eastman. *(April 18)*

MILWAUKEE loses in activated-sludge patent infringement fight as the U. S. Court of Appeals at Chicago refuses to permit the city to re-open the case favoring Activated-Sludge, Inc. *(April 18)*

DRIVING 1,735 ft. from a single heading in 31 days, Golden Cycle Corp. sets new world's tunneling record on the Carlton Drainage Tunnel. *(April 18)*

COMPLETION OF THE $170,000,000 Upper Mississippi canalization marked March 13 when Dam 24 was placed in operation. *(April 18)*

U. S. SUPREME COURT confirms its adjudication of 1936 apportioning of the waters of the Laramie River between Colorado and Wyoming, which limited Colorado's diversion to 39,750 acre-ft. *(April 25)*

CITIZENS of Philadelphia approve an $18,000,000 bond issue for rehabilitation of the city's waterworks. *(April 25)*

RESTRAINING ORDERS halting construction of the $6,500,000 hydroelectric project being built on the Yadkin River by the city of High Point, N. C., upheld by North Carolina State Supreme Court. *(April 25)*

### MAY

CONSTRUCTION begins on Rainbow Bridge, a steel arch across the river gorge at Niagara Falls. *(May 9)*

TWENTY-FIVE CONTRACTORS employing 12,000 men on 28 different contracts pave 5 miles of four-lane pavement daily as Penn Turnpike nears completion. *(May 16)*

EARTHQUAKE causes damage estimated at $5,000,000 in Imperial Valley of California and Mexico. International Canal in Mexico broken and buildings and water reservoirs badly damaged in California towns of Imperial, Holtville, Brawley, and El Centro. *(May 23)*

U. S. DEFENSE PROGRAM starts as Congress rushes through three-billion-dollar Army and Navy appropriation bill, which contains $200,000,000 worth of construction. *(May 30)*

### JUNE

CHICAGO announces plans for $60,000,000 three-year program for rehabilitation of its transit system. *(June 6)*

FEDERAL AID for highways for the fiscal years 1942 and 1943 reduced 25 percent by the House, making total appropriation for each year $178,500,000. *(June 6)*

ENGINEER-ARCHITECT CENSUS starts to marshal forces for the nation's defense program. *(June 13)*

NATIONAL DEFENSE legislation adds $75,000,000 of Army and Navy airbase construction. *(June 13)*

DETROIT'S new $27,000,000 sewage treatment plant and collecting system, dedicated. *(June 13)*

NEGOTIATED CONTRACT for the $23,381,000 Corpus Christi, Tex., airbase is Navy's first use of its new powers to award work on such a basis within the United States proper. *(June 20)*

PHILADELPHIA'S $10,000,000 airport covering 494 acres dedicated and placed in operation. *(June 20)*

ENGINEERING SCHOOLS of the nation drawn into the defense program in accordance with a $14,000,000 plan formulated by Commissioner John W. Studebaker, U. S. Office of Education, at the request of President Roosevelt. *(June 20)*

NATIONAL DEFENSE COMMISSION asks President Roosevelt to obtain Congressional approval for 300,000 kw. additional Tennessee Valley Authority power. *(June 27)*

EAST RIVER DRIVE opened to traffic in New York City. The express-way is part of a future non-stop highway that will circle Manhattan by incorporating existing West Side Elevated Highway and Harlem River Speedway. *(June 27)*

RELIEF BILL passes with $100,000 cost limit on buildings other than defense construction. *(June 27)*

### JULY

USHA GETS legislative power to meet defense housing needs as projects are made exempt from the local-contribution requirements and from tenant-income restrictions. *(July 4)*

PANAMA CANAL engineers start construction of the third set of locks to cost $227,000,000. *(July 11)*

LAKE WASHINGTON pontoon bridge and Tacoma Narrows suspension span opened to traffic. Both bridges were built by the Washington Toll Bridge Authority, the first costing $9,000,000, the second $6,400,000. *(July 11)*

FIRST TIED-ARCH BRIDGE across the Mississippi River completed and opened to highway traffic at Rock Island, Ill. *(July 11)*

SIX-YEAR PLAN made mandatory for federal construction as National Resources Planning Board, working with Bureau of the Budget, gets practical connection with federal program. *(July 11)*

BIGGEST CONSTRUCTION WEEK in history is recorded as Bureau of Yards and Docks lets $140,000,000 of contracts and Army awards $30,000,000 worth of work. *(July 18)*

CONSTRUCTION begins for $5,000,000 Technological Institute building at Northwestern University. *(July 18)*

PLACING OF CONCRETE begins for $80,000,000 Bureau of Reclamation Shasta Dam on the Sacramento River in California. *(July 18)*

## AUGUST

NAVY PUBLIC WORKS to meet 70 percent naval expansion will require $750,000,000 during next five to seven years. Congress studies bill to provide $96,000,000 for start of work. *(Aug. 1)*

FIRST BUCKET OF CONCRETE for Friant Dam placed July 29. *(Aug. 1)*

AMERICAN SOCIETY OF CIVIL ENGINEERS votes to withdraw from American Engineering Council. *(Aug. 8)*

DESIGN CHANGES increase cost of Mud Mountain Dam on the White River near Seattle, Wash., by more than $1,000,000. *(Aug. 8)*

TVA BEGINS WORK on Cherokee Dam as part of a $65,000,000 program recommended by the Defense Commission to provide additional power. *(Aug. 8)*

TVA SIGNS labor-management agreement with the Tennessee Valley Trades and Labor Council. New arrangements for settling disputes over pay and working conditions provided and strikes outlawed. *(Aug. 15)*

ARMY awards first fixed-fee contracts for $20,000,000 tank plant, $25,000,000 powder plant, and a $6,150,000 general depot. *(Aug. 22)*

COMBINED highway and railroad bridge across the Mississippi at Baton Rouge, La., goes into service. *(Aug. 22)*

ARMOUR AND LEWIS institutes at Chicago join to form Illinois Institute of Technology. Henry T. Heald, president, of Armour, heads new set-up. *(Aug. 22)*

SARDIS DAM, a $15,000,000 U. S. Engineer project, on the Little Tallahatchie River in Mississippi, is dedicated. *(Aug. 22)*

ARMY starts housing work for 400,000 conscripts and national guardsmen with $29,000,000 allotment from President Roosevelt's $2,000,000 "blank check" fund. Many contracts awarded to start an over-all program to house 1,000,000 men at a cost of $60,000,000 to $70,000,000. *(Aug. 29)*

FIRST WATER from the Central Valley Project in California is delivered via Contra Costa Canal to city of Pittsburg, Calif. *(Aug. 29)*

## SEPTEMBER

CONGRESS speeds defense construction bills as Army and Navy let contracts for a $14,250,000 ammunition loading plant, a $7,500,000 army housing job, and large airplane factories. Senate completes action on $5,133,000,000 total defense appropriation bill, already passed by House. *(Sept. 5)*

PUBLIC ROADS ADMINISTRATION demands defense priority for federal-aid work being carried out by state highway departments as it refuses to approve Oklahoma's program because the work was not concentrated on strategic routes. *(Sept. 5)*

BUREAU OF RECLAMATION completes its $38,500,000 All-American Canal to supply the Imperial Valley in California with Colorado River water. *(Sept. 5)*

HANSEN DAM dedicated. It is major unit of the $70,000,000 Los Angeles County flood control system. *(Sept. 12)*

INLAND and coastal water carriers placed under federal regulations similar to those now covering motor and rail transportation by bill passed by Senate. *(Sept. 12)*

OVER half billion dollars of construction money to finance conscription housing and other defense operations sought by President as conscription advance. *(Sept. 19)*

LUMBER PRICE CONTROL sought by Defense Commission as the nation's lumber industry operates at 75-percent capacity but expects heavy demands for barracks construction. *(Sept. 19)*

NATCHEZ BRIDGE across the Mississippi River at Natchez, Miss., is dedicated and opened to traffic. *(Sept. 26)*

MARSHALL FORD DAM goes into operation to increase flood control on the Colorado River in Texas. *(Sept. 26)*

## OCTOBER

BLACK RIVER highway bascule bridge with a 333-ft. span is completed at Lorain, Ohio. *(Oct. 3)*

COMBINED 40,000,000-gpd. Gary, Ind., sewage and garbage disposal plant is dedicated Sept. 26. *(Oct. 3)*

WORK IS RESUMED on the $6,492,600 hydroelectric plant being built by the city of High Point, N. C., on Yadkin River, following a favorable court decision. *(Oct. 3)*

THOMAS A. EDISON highway bridge over the Raritan River between Perth Amboy and South Amboy, N. J., opened to traffic. *(Oct. 10)*

DEFENSE HOUSING BILL, providing for $150,000,000 construction and empowering the federal works administrator to build the houses and rent them to defense workers, passed by Congress. *(Oct. 10)*

PROPOSED $80,000,000 civil airport construction fund cut to $40,000,000 by Congress and passed in that form. *(Oct. 10)*

FORMATION OF National Sewage Works Association gets unanimous approval at first convention of state and local associations as 550 sewage works men gather at Chicago. *(Oct. 10)*

INDICTMENT against five lumbermen's associations, 168 lumber companies and 53 company officials obtained by Department of Justice. That recent increases in lumber prices are a result of collusion of producers is the charge. *(Oct. 10)*

SHIPYARD CONSTRUCTION begins for the U.S. two-ocean navy as $96,931,000 of contracts are awarded for shipyard and ordnance facilities to make the biggest construction week ever recorded by *ENR*. The week's grand total of awards is $238,793,000. *(Oct. 17)*

RIVERS AND HARBORS BILL passes with $37,085,000 of defense work included. *(Oct. 17)*

PHILADELPHIA'S $42,000,000 bond issue to finance improvements to the sewer system of that city is held unconstitutional by Pennsylvania State Supreme Court. *(Oct. 17)*

BOSTON'S new pressure aqueduct extending from Southboro to Weston is dedicated and goes into service. *(Oct. 31)*

PENNSYLVANIA TURNPIKE opens to traffic Oct. 1 with tolls for passenger cars set at $1.50. *(Oct. 31)*

GROUND IS BROKEN for the Brooklyn-Battery vehicle tunnel at New York Oct. 28 by President Roosevelt.

## NOVEMBER

DEFENSE HOUSING started by Public Buildings Administration as a $1,935,000 contract is awarded for a 700-dwelling project at Fort Knox. *(Nov. 7)*

PENSACOLA DAM in Oklahoma, world's longest multiple-arch dam, finished at a cost of $22,500,000. *(Nov. 7)*

THE 2,800-ft. main span of the Tacoma Narrows suspension bridge is wrecked Nov. 7 by a 42-mph. wind. *(Nov. 14)*

FORT PECK DAM hydraulic-fill work is completed Oct. 11 at a cost of $122,900,000. *(Nov. 14)*

NEW YORK CITY'S $58,000,000 Queens-Midtown Tunnel goes into service as first vehicle tunnel under the East River. *(Nov. 21)*

## DECEMBER

PREFABRICATION for defense housing project in Maryland ordered by Public Buildings Administration. A total of 650 units using twelve different types of prefabrication will be constructed. *(Dec. 12)*

FIRST HOUSING to be done by the Federal Works Agency under the Lanham Act starts. *(Dec. 5)*

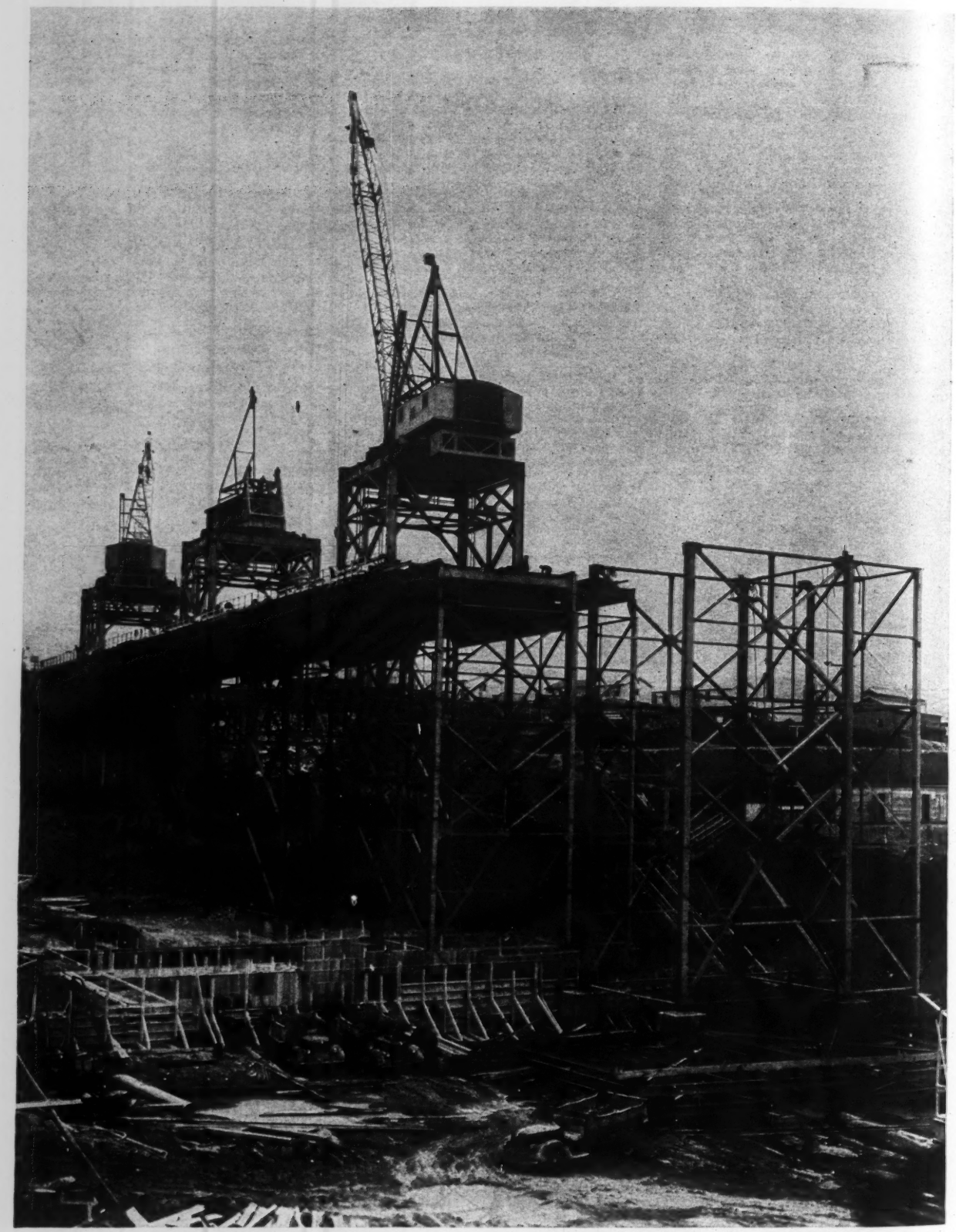
KINGSLEY DAM hydraulic-fill work on the North Platte River ends as Central Nebraska Public Power & Irrigation District Dec. 9 completes placing of 26,000,000 cu.yd. *(Dec. 12)*

F. E. SCHMITT retires from editorial staff of *ENR* after 38 years of service to join Bureau of Reclamation in advisory capacity. *(Dec. 19)*

FEDERAL CONTROL of streams includes all rivers that can be made navigable, U.S. Supreme Court rules in 15-yr.-old New River case. *(Dec. 19)*

CROSS-CONNECTION contaminates Rochester, N. Y., water supply with 4,000,000 gal. of polluted Genesee River water. Quick action on the part of city and state health authorities prevents epidemic. *(Dec. 19)*

YEAR 1940 ends as biggest construction year ever recorded by *ENR* with nearly $4,000,000,000 of heavy construction awards reported. *(Jan. 2, 1941)*



**MORE POWER FOR NATIONAL DEFENSE. First concrete for Cherokee Dam being placed on Jan. 1, 1941 as TVA girds itself to have generators turning next year. Some 700,000 yd. of concrete and 3,000,000 yd. of earth will be piled into a dam 6,600 ft. long and 173 ft. high, located 26 airmiles northeast of Knoxville.**

# REVIEW AND FORECAST 1940-1941

## Past, Present and Future

THE WORLD TODAY leaves little time for looking backward and offers precious little incentive for prying into the future. Nevertheless, looking backward that we may move forward is a profitable process, nowhere more successfully practiced than in civil engineering and construction, where precedents often determine both the pattern and the pace of progress. And in an industry as broad as construction, useful precedents are found in many fields, among them business, government, labor relations, professional affairs and technological activities. To a marshalling of these precedents and of the facts and figures that support them, this issue is devoted.

## Half Peace, Half War

THE FIRST THING that a look backward reveals is that 1940 cannot be regarded as a twelve-month period so much as two six-month periods. From January to June, domestic problems confronted construction; in many respects it was the most normal period for a decade. WPA rolls were going down. PWA financing had stopped, and local governments were beginning to reassume responsibility for their own destinies. Housebuilding increased, industrial and utility construction were active. Despite war in Europe, profitable peacetime activity was almost an actuality. Then France collapsed, and with it went Congressional complacency with our defenses. Peacetime pursuits gave way to preparation for war. With steadily rising tempo, these preparations dominated all else. Life, as we know it today, began in the last half of 1940. In general, much of what happened in the first half is today inconsequential.

## Forces of Nature

SOME EXCEPTIONS to such appraisal are, however, necessary. Technological developments, for example, always present a year-round spectacle, and are considered as such in the reviews of specialist fields elsewhere in this issue. Nature, too, is unaffected by such man-made issues as national defense, and, in 1940, managed to spread its unusual actions broadly both in point of time and geographically. A severe winter in the South exacted a heavy toll in frost-bitten roads that showed up in the spring. A tornado wrecked the business district of Albany, Ga., in February. The Sacramento River Valley experienced its worst flood in March, and in May the most damaging earthquake since that of 1933 at Long Beach wrecked buildings and irrigation works in California's Imperial Valley. A tropical hurricane caused record-breaking floods in the Carolinas in August, and November witnessed Great Lakes cities being lashed by a severe winter storm and East Texas experiencing the highest monthly rainfall in history.

## Business Down, Then Up and Up

THAT THE FIRST HALF of the year was out of tune with the times to come is nowhere better shown than in the business curve. From 123 at the beginning of the year, the *Business Week* index dropped to 105 by April. The discomfiture of optimistic business prophets was, however, temporary. In May the upturn started, and with hardly a falter the index reached a peak of 142 in December. For a decade the country had been looking for a new industry to lift it out of the depression, and the rising business curve was a response to the demands of that new industry—munitions production. It caused airplane manufacturing facilities to double and to start on the road to quadruple in floor space. It required machine tool builders to turn out $700,000,000 of orders in 1940, which is $150,000,000 more than they had ever done before. It increased textile mill activity to an index of 140 compared to 115 in 1929 and 132 in 1939. It brought all mining facilities into production and caused the importation of copper, zinc and lead, which are normally home-produced in excess of demand. It brought chemical production 15 per cent above 1939, to the highest point in history, and caused the building of new plants which will swell this total greatly. And as a result of munitions requirements electric power output reached 145 billion kw., a new peak by 11.5 percent.

## Construction the Spearhead

IF BUSINESS WAS GOOD, construction was better. As the spearhead of defense it was its job to build the

facilities to tool up this munitions industry. After following the 1939 rate (although at a slightly lower level) for six months, contract awards jumped to a pace never before equalled. Several different weeks topped 200 million dollars, more than 10 percent above any previous weekly record. Total engineering construction contracts reported exceeded the historic boom year of 1929, reaching a total of $3,987,243,000; and two-thirds of this total was let in the last six months of the year. Biggest contributors to the record were industrial buildings; public buildings (swelled by many government-owned factories); and the unclassified category in which are the airbases and shipyards. Roads, too, were at a new top, 5 percent above 1939, but bridges were 20 percent down. Commercial buildings were slightly better, but waterworks and sewerage, minus the PWA impetus of recent years, dropped 57 and 43 percent below their 1939 totals. When residential building is added in, the year's construction was slightly over eight and a half billion dollars.

## Regular Jobs Once More

AN ACCOMPANIMENT of this construction activity was a substantial increase in employment. Construction workers, depressed by the "WPA or nothing" situation of recent years, welcomed the change to regular rush jobs. Total construction workers exceeded 2,800,000 at the end of the year; there were 3,340,000 employed in 1929 and about 2,200,000 in 1939, according to the National Industrial Conference Board. Unemployment dropped from 9,000,000 to 7,000,000 during the year. How many of those remaining out of work can meet industry's requirements is a moot question. Unionization of defense construction was agreed to widely in the interest of eliminating labor disputes and strikes, a practice which apparently met with success for little work was delayed by labor trouble. At the end of the year, skilled labor shortages were beginning to show up locally, despite union assurances that they could meet any demand; but since the cantonment building program is reaching its peak it is possible that the labor situation will get no tighter. A great shipbuilding program in the offing at the year end promised to absorb an army of new workers, many of them no doubt from construction's rolls.

## Costs Remarkably Steady

PARADOX of the rise in construction activity was the steady character of material costs, lumber excepted, and of hourly labor rates. Because of overtime charges after 40 hours, total labor costs were, however, substantially higher than if leisurely 40-hour weeks could have been worked. Lumber, stimulated by huge demands for cantonment construction, rose sharply in price, a rise that brought a sweeping anti-trust indictment by the Department of Justice. Threats to take over the lumber industry or to impose price curbs were made by federal authorities.

## Materials Supplies Ample

DESPITE an unprecedented volume of work, supplies of construction materials proved ample. Lumber, partly as a result of unplanned purchasing for cantonment work, developed some temporary local shortages, but cement, structural steel, brick, stone, reinforcing bars and those countless commercial products that go into modern building were available where and when needed. Controversy over the adequacy of steel making capacity at the end of the year suggests the possibility of a shortage of this basic material for jobs not connected with defense. Zinc and copper are two other building materials in which shortages may appear as the result of their wide use for national defense. And aluminum, despite current expansion that will double ingot capacity, will not be a building material so long as airplane demands continue to grow.

## Fixed Fee Contracts

WITH COSTS REASONABLE, labor satisfied and materials available, management could devote full energy to getting its jobs done quickly. A major lift toward this objective was given when the Navy and then the Army adopted the negotiated cost-plus-fixed-fee type of contract for defense construction. Speed in getting the job under way, flexibility in handling charge orders, free choice in getting the best contractor for the job, were advantages to the government. Beyond being insured against losing their shirts and being freed of the necessity of providing large sums for working capital, contractors were not particularly benefited. Fees were generally under 5 percent, some as low as 2 percent. Furthermore it was principally the large contracting organizations that got the jobs, although some smaller firms were beginning to land more business at the year end while a good many others had loaned personnel and equipment to the larger contractors and were thus participating indirectly. Fixed-fee contracts introduced a lot of new problems into the business of construction, but contractors generally are mastering them to their own and the government's satisfaction.

## Engineers on Defense

CONTRACTORS were not alone in finding themselves in a new environment as a result of national defense. Engineers, too, were called to the colors as it were, most of them to serve as aids and consultants to the Army's Quartermaster Corps; the Navy had ample personnel in its Bureau of Yards and Docks and among its reserve public works officers and did not require civilian help. Both Army and Navy, however, farmed out huge batches of design work, which provided many engineering jobs; and here, as in construction, the large firms derived the most benefit. Since engineers have always worked on a negotiated contract basis, they, unlike the contractors, had no radically new business arrangements to cope with.

## Professional Developments

OF DEVELOPMENTS affecting the engineer's business and governmental relationships, however, there were the usual number. Important among them was acceptance by the Arizona Highway Commission of a salary and classification schedule for its engineering employees, worked out by the American Society of Civil Engineers. Similar schedules have been prepared for Nevada, but are not yet approved, and eight other states have expressed an interest in the idea, which is the first practical demonstration that engineering societies can supply their low salaried members with a type of economic service heretofore rendered only by trade unions. Another event of interest to salaried engineers was a redefinition of professional work under the wage-hour law, which not only brought more men into this desirable classification but prescribed a minimum salary of $200 a month for them. Trending in the same direction is the decision of the Ohio Society of Professional Engineers to set up junior and student grades so that young men coming up in the profession will have the support of the older engineers in meeting their economic problems. The year 1940 saw the final disintegration of American Engineering Council after 20 years of service in representing engineers in the nation's capital, an event that emphasized the difficulty of securing unity of action among engineers on important national questions.

## New Conditions and Problems

OUT OF A PERIOD of such cataclysmic change, new conditions and problems are bound to emerge. Some of these have immediate repercussions, the effect of others will come later. Among the last named is the emergence of government ownership of industrial plant; public buildings of 1940 were not post offices but factories. Significant, in the opposite sense, is government encouragement of private power expansion. A condition already with us is curtailment of municipal public works, particularly new water supply and sewerage facilities; priority for defense construction made this inevitable. Slum clearance housing has also had to take in sail, while emphasis is put on housing for defense industry workers; an important change is a shift from structures to last 60 years to a type, perhaps prefabricated and demountable, whose life need only be that of the emergency. So far, peacetime federal public works have not been greatly curtailed, excepting perhaps river and harbor work. And while there have been no changes in federal aid to roadbuilding, the status quo in itself is a problem because neither states nor cities are willing or able to handle needed defense roads with the money available.

## Things to Come

LOOKING AHEAD into 1941, the civil engineering and construction pattern is relatively easy to define. It will be more of the same. A huge munitions factory program is under contract, but another of almost equal size is being formulated. The present cantonment building program will be finished by June, but new and large additions to it are in the making. The Army and Navy airbase work on the continent will not wind up this type of work; its duplication on Atlantic and Pacific islands is already under way, and million-dollar contracts will soon dot the country for municipal airport expansion. Shipyard expansion, already begun, could at least double in size. Finishing up current flood control and reclamation projects remains a job of considerable magnitude. Roadbuilding activity can hardly decline, and the odds favor a substantial increase. Under the impetus of increased national income, private construction of commercial buildings, housing and factories is not a field to sell short, even in the face of threatened cost rises or material or labor shortages. Municipal public works, such as water supply and sewerage, will bring up the rear, but will by no means be at depression levels; population shifts and industrial activity always require new and improved municipal services. In 1940, engineering construction nearly touched the four billion dollar mark; in 1941 it will exceed it. Total construction was 8½ billions; best possible guess for 1941 is that it will be up 11 percent to 9½ billions at end of year.

# Municipal Works and Worries

**An appraisal of performance and a forecast of developments in municipal engineering, public works financing, water service and sewage and refuse disposal**

***Edward J. Cleary***

To INTERPRET what has occurred and relate it to what may take place in the field of municipal public works is the dual objective of this review. The transition from a peacetime to a wartime economy, which began last summer, calls for reappraisal of old problems and an estimate of new ones. What does this transition mean in terms of planning and financing municipal services—in regard to the extension of water supply, sewage and refuse disposal facilities? And what technical and economic developments may be expected to influence the execution of such works?

From the phantasmagoria that characterized municipal activity during the last decade some definite patterns begin to take shape—patterns, however, that delineate problems rather than solutions. For instance, if we could peer into the mind of a municipal administrator who had carefully sorted his thoughts at the end of 1940, we might find something like this:

*Traffic Congestion*—To cope with this problem it must be recognized that street systems were designed prior to the introduction of the automobile. Therefore, we need a new concept of city thoroughfaring. To this end construction of limited-access motorways offers perhaps one solution—albeit a costly one. Notable examples of such undertakings recently are New York's East River Drive and Belt Parkway, Pittsburgh's beginning on a ten-lane belt line around the Golden Triangle district, Chicago's eight-lane Lincoln Park through-road with its unique elevating and retracting curbs to separate traffic, and the $250,000,000 superhighways proposed for Los Angeles.

*Financing Public Works*—Because a city must maintain and constantly add to its public works facilities and services, yearly budgets generally get larger. But the income from taxes remains fixed or gets smaller. Since the tax rate cannot be raised indefinitely, new sources of revenue must be found to make the city function. Los Angeles, for example, is thinking about tolls to finance its quarter-million-dollar superhighway system. Many other cities, of which Philadelphia and New York are notable examples, are contemplating the use of service charges to pay for sewage disposal.

Reflecting on the role of PWA and WPA in city public works activities, one authority ventures the suggestion that if municipal revenues are inadequate, cities perhaps must look for continuing financial assistance from superior levels of government having greater revenue-raising powers. Acceptance of this principle might provide an easy way out but it should be remembered that he who pays the piper also calls the tune. Few municipalities are willing to forego the privilege of "calling the tune," even if they don't care who pays the piper.

*National Defense*—A new set of conditions occasioned by national defense impinged on municipal affairs

***Fig. 1. Pedestal-type "watersphere," which was a 1940 innovation in storage structures. This one at Shakopee, Minn., of all-welded steel construction, is 90 ft. high and has a capacity of 250,000 gal.***

in the summer of 1940. No one can predict what the ultimate effect will be, but obviously it will require reorientation of city public works planning and financing, changes in personnel, and inauguration of a new activity in civilian defense.

Industrial cities already have felt the pressure for additional housing and extension of public works facilities. If this expansion is not examined carefully in the light of probable post-war conditions and tied in with future plans of development, some costly mistakes are inevitable. Caution is the order of the day on capital improvements.

Despite the previous unfortunate experience of many municipalities which built airports for which there was little use except as a burial ground for maintenance money, there is renewed enthusiasm for the construction of these facilities. It has been established, however, that such undertakings are expensive and unwarranted unless they fit in with the broad plans of the federal government and are eligible for federal aid.

Enrollment of men in the army and the resignation of trained public employees to accept better paying jobs in private industry is creating a serious problem in municipal staffing. This calls for intensive training of subordinates so that they will be available to fill posts of greater responsibility when vacancies occur.

And finally, plans for civilian defense. There is little on which to work at present but the matter is actively under study by a number of groups. Prominent among these is a committee of the American Society of Civil Engineers, which is studying (1) sanitation and public health measures; (2) maintenance of power facilities; (3) transportation planning; (4) bomb-resistant structures; and (5) disaster control and sabotage. In January a national committee of seven engineers closely allied with this Am. Soc. C. E. committee was appointed by the War Department to assist in the formulation of civilian defense plans.

#### Sewage disposal slows down

Sanitary engineering activities shifted into second gear after a decade of great accomplishment. The year 1939 with its all-time high expenditure of $150,000,000 for sewage disposal and $163,000,000 for water supply construction marked the peak of this era. With the flow of federal funds stoppered and with the psychology of the nation shifted from domestic pursuits to national defense, there has come marked deceleration in sanitation works construction. The 1940 statistics—sewage disposal, $91,000,000, water supply $70,000,000—compared with those for 1939 tell the story.

In retrospect, highlight events of the past year in sewage disposal are significant for what they reveal regarding future trends. For example, the high-rate shallow filtration process—a novelty just a few years ago—was sky-rocketed into prominence, and more than 40 installations already have been made or are under contract. Because of its flexibility and ruggedness, particularly under varying load conditions, this process has been favorably considered for the new army camps. Said to be 30 percent lower in construction cost and as much as 40 percent lower in operating cost than the standard trickling filter system, the process seems slated to achieve wide popularity.

Another highlight of the year was the controversial interest in the utilization of sludge for fertilizer. When it comes to sludge disposal there are two sharply divided schools of thought. One group urges, "Burn it and forget it"; the other group, with an eye to salvage, says, "Process it and sell it." The economy-minded latter group, supported by new findings which show that sludge contains "fertility" values (growth-promoting substances such as indole and skatole) which outweigh chemical standards of fertilizer content, believe that proper sales promotion of sludge will provide a substantial source of revenue. However, experience at Milwaukee, one of the biggest and oldest producers of fertilizer from sludge, dispels the thought of profit; figures covering a 12-yr. period show that the cost of production per ton averages $23.34, while the return is only $14.96.

Meantime, the activity of Chicago in shipping sludge as far away as Florida where the material is used by fertilizer manufacturers as an organic filler, has captured the imagination of some major cities. It is rumored that rail and boat freight rates are being carefully scrutinized in connection with operating studies on new and recently completed disposal plants along the Atlantic seaboard.

Although fertilizer production for profit is debatable, there is no question about the byproduct value of sludge gas collected from the digesters. The use of this gas as a fuel for internal combustion engines is constantly increasing and News-Record's *Engineering and Construction Markets* (January, 1941) reports that there are now 141 engines in use or under installation totaling 29,122 hp. The engines, ranging in size from 12 to 1,440 hp., are employed for driving pumps, blowers and generators. One authority estimates that the gas from a city of 100,000 population has a potential value of $17,000 if applied in the development of power.

#### Stream pollution advances

Stream pollution abatement envisions adequate treatment of both domestic and industrial wastes, the latter contributing as much pollution, if not more, than that which arises from municipal wastes. With the splendid progress made during the last decade in the installation of municipal treatment works, it was logical to assume that 1940 might usher in an era of widespread industrial waste treatment. But events have conspired to dash this hope, at least "for the duration" of the defense program.

In the first place, national legislation which would have put the power of federal law behind public sentiment for stream clean-up was sidetracked again as it has been for the last seven years; the Congress has agreed that "there ought to be a law" but there is complete lack of agreement as to how far the law should go in disqualifying pollution and how much federal money should be allotted to implement the act. Further, no one is going to be so brash as to confront industry with demands for waste treatment at a time when every effort is being bent to speed national defense work.

However, a big step forward in a united and intelligent approach to stream pollution abatement was registered when Congressional approval was given this year to the formation of two interstate compacts for control of pollution in the Ohio and Potomac Rivers. The Ohio River compact, already signed by New York, Illinois, Kentucky, Indiana, Ohio and West Virginia, now awaits ratification by Pennsylvania and Tennessee before it becomes effective. The other bill, permitting the establishment of the

Potomac Valley Conservancy District, involves Maryland, Virginia, District of Columbia, West Virginia and Pennsylvania; all except the last two have signed.

Biggest job of the year in purpose and ultimate effect on stream pollution abatement is the comprehensive study of river uses and abuses being made by the Ohio River Committee. Working without fanfare, this combination of War Department and U. S. Public Health Service engineers has completed the second year of a three-year study in the drainage basin of the Ohio River. The task is one of fact finding, interpretation of data and drafting of a program leading to the adoption of remedial measures for stream clean-up in a 14-state area involving 204,000 sq.mi. When the final report is made (scheduled for 1941 due to a speed-up), we may have the basis for new concepts in the evaluation of stream standards.

For the immediate future it appears that progress in sewage disposal—as measured by new plant construction—will be slow. Several of the larger cities—notably Philadelphia, Boston, Louisville and Los Angeles—have projected plans for major expenditures, and hundreds of smaller communities are in need of proper disposal facilities, but these projects will probably be delayed while defense work goes on. The biggest jobs under way are the $10,000,000 addition to Chicago's Southwest plant and the $6,000,000 program for several plants in New York City.

Progress for the next year or so more likely will be measured in terms of research accomplishments and developments leading to perfection of processes and equipment. Toward this end the recently reorganized and expanded Federation of Sewage Works Associations should be a vital and stimulating force.

#### Water supply developments

In the field of water supply the 1940 calendar of activities recorded several portentous happenings, of which two call for special comment in relation to what they hold for the future: (1) announcement last April that a federal code of waterworks practice is in the making; (2) the Supreme Court decision in the New River case which broadens federal control over rivers.

Tipoff to waterworks men that new federal regulations embodying a code of practice are being formulated was given by FSA Administrator Paul V. McNutt at the annual meeting of the American Water Works Association. Details concerning this code of water quality standards are not available. However, it is known that the code will widen the scope of regulations first promulgated in 1914 and revised in 1925, which deal with sanitary control of drinking water furnished to interstate carriers. Some municipal, state and industrial officials view with alarm the implication that the federal government may be preparing to exercise new powers in waterworks practice.

If this view should prove to be unwarranted so far as a code of regulation is concerned, there is no doubt about widened federal control over stream uses. On Dec. 15 the U. S. Supreme Court in what is popularly known as "the New River case," ruled in effect that if a stream (no matter how small) can be improved by dredging or construction of dams so that it will float a barge or even logs, it may be classed as "navigable," and is thus under federal and not state control. Private and public bodies may well ponder the possible effect of this decision on water supplies, power, irrigation, waste disposal and other uses to which streams are put.

In the late spring of 1940, when the wheels of industry began to speed up for national defense needs, the editors of *Engineering News-Record* became convinced that sabotage of water service might become an eventuality as a means of crippling production and demoralizing community morale. Accordingly, a nationwide survey was undertaken among waterworks authorities to determine what steps might be taken to safeguard water supplies. This survey resulted in a report outlining precautionary measures. Widely publicized, this report started discussion and helped to stimulate action by water utilities from coast to coast. Many of the things that should be done are nothing more than the extension of normal improvement work as dictated by good practice.

Outstanding among new technical developments was the introduction of "break-point" chlorination for the elimination of taste and odor. Based on research conducted by the Wallace & Tiernan Co., Inc., the new technique involves the application of chlorine to a predetermined dose, at which point a change of condition will occur resulting in a sudden drop of residual chlorine; as more chlorine is applied this is followed by a breakdown of taste-producing substances. Other benefits such as color removal, better coagulation and more complete bacterial removal also result. An average dose of from 3 to 6 ppm. of chlorine is required for "break-point" action.

A different form of attack on taste and odor problems—using ozone—was launched at Denver, Pa. Here a 300,000-gal. filter plant was built and provisions were made to apply ozone gas to the water by means of diffusers and an absorption wheel device located in the clear well. As yet, no operating results have been reported. Meantime, Philadelphia is completing the construction of a 1-mgd. experimental plant to determine the merits of ozone in the purification of its water supply. The plant, which will have ozone-generating equipment of 20-lb. capacity, is being built with funds supplied by the city and by Ozone Processes, Inc.

Big water supply undertakings, in which are included the Baltimore tunnel, Boston aqueduct, Chicago filter plant, Delaware aqueduct, Harrisburg mountain supply, Metropolitan Water District of Southern California softening plant, Toledo lake supply, and Wichita pipeline, are discussed in detail in the major projects section of this issue.

Among other significant happenings of the year were the following:

Rochester's narrow escape from an epidemic of typhoid when the domestic water system was filled with polluted river water through inadvertent opening of a cross-connection valve.

Sudden and unaccounted-for popularity of the all-welded steel pedestal type water tank, of which ten installations were made this year shortly after the first structure was erected in Longmont, Colo.

New findings on siphon hydraulics by the Army Engineers which resulted in the construction of a siphon on the St. Francis River project with a discharge coefficient of 0.97. Heretofore, the highest value obtained with large siphons was 0.75.

The radial water collector, which was a novelty when it was first described in *Engineering News-Record* (Oct. 22, 1936, p. 576 and Jan. 6, 1938, p. 25) is quietly making a bid for popularity. In one of the big

powder plants now under construction five wells of this type are being installed (total of 100 mgd. capacity), three other industrial installations have been completed, and several municipalities are using them or planning their use. The collector consists of a shaft, which is sunk to water-bearing strata, on the bottom of which screen pipes are driven radially in a horizontal plane.

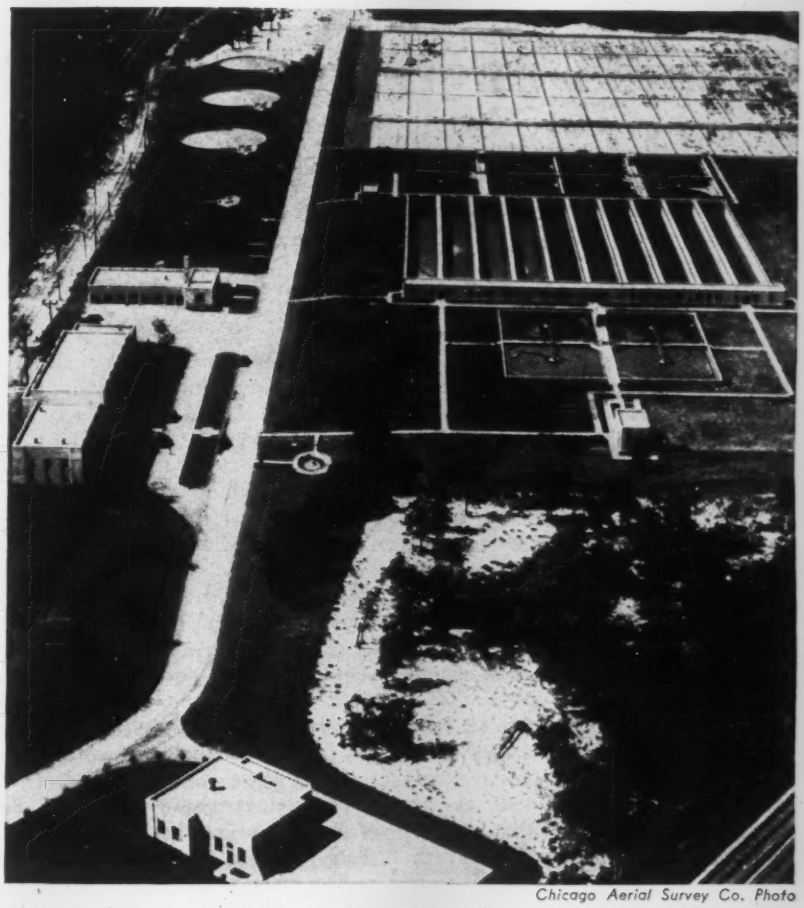
**Refuse disposal progress**

In the field of refuse disposal, one of the major events was the completion of dual disposal plants—in which garbage is ground and treated along with sewage—at Gary, Ind., and Rock Island, Ill., and the availability of operating results from the pioneer plant at Lansing, Mich. At the latter place, where 21 tons of garbage a day are ground and deposited in digester tanks along with sewage sludge, these important findings were revealed: (1) Sewage and garbage solids digest readily and thoroughly; (2) gas production, following the addition of garbage solids, increased by 230 percent; and (3) bones, eggshells and fruit pits are the cause of serious clogging in sludge pipes.

At Gary, a 40-mgd, activated-sludge plant has been designed to handle the entire output of garbage from the city, estimated to be from 30 to 35 tons; byproduct gas for power production has an estimated minimum value of $13,000, this amount said to be equivalent to an 8 percent return on the cost of garbage grinding and additional digester capacity.

Rock Island, Ill., will handle municipal waste of all kinds from a population of 50,000 at its new disposal plant. Sedimentation and magnetite filters provide for treatment of sewage and ground garbage, while incineration facilities will burn sludge and trash. Byproduct gas from the sludge digesters is expected to produce power for all pumping and plant operation needs. Other garbage grinding plants are reported soon to go in operation at Marion, Ind., Findlay, Ohio, and Goshen, N. Y.

New findings by the U. S. Public Health Service on the widespread prevalence of trichinosis (a parasite disease transmitted by eating improperly cooked pork from infected hogs) is an alarming indictment of garbage disposal by hog feeding. More than half of 754 cities surveyed



Chicago Aerial Survey Co. Photo

***Fig. 2. Sewage treatment and garbage disposal facilities are combined in this new plant at Gary, Ind. The plant will handle 40 mgd. of sewage plus the entire garbage output of the city, estimated to be 35 tons daily.***

disposed of municipally collected garbage in whole or in part by feeding it to hogs. Pasteurization and dehydration of garbage are being studied, however, in a search for improved hog feeding practice at Fontana Farms near Los Angeles.

After three years' experience and refinement of landfill disposal procedure in New York City, reports indicate that it is an overwhelming success. One-third of the city's refuse (some 9,000,000 cu.yd.) is disposed of in this fashion, as a result of which about 120 acres of marshland is reclaimed, and a saving of $2,000,000 is made yearly. The latter figure is based on average disposal costs of 30.5c. per cubic yard for incineration and 7.5c. for landfill. In addition to landfill the city incinerates about 9,000,000 cu.yd. of refuse and disposes of an equivalent amount on an open dump on an island.

Activity in new incinerator construction shows the consistent gains which are being made in the adoption of this method of disposal. Some 38 installations are reported for 1940 as compared with 16 plants last year. It is estimated that there is a total of over 800 incinerators in this country and Canada.

The new year opened with the possibility that salvage from municipal refuse may occupy renewed attention. Although there are at present only a few garbage reduction plants operating, the fact that garbage grease contains a valuable glycerine content may serve as a motivating factor in renewed interest in extraction processes. Garbage grease is now quoted at about 4 cents a pound, but during the last war period it brought up to 13c.

It is also to be noted that the Washington Suburban Sanitary District at Hyattsville, Md., is baling tin cans and selling them for $9 a long ton (2,200 lb.) delivered to a Baltimore chemical works.

# Bridge Design and Construction

**Reappraisal of suspension bridge design practice, longer girder spans, some interesting new structures and progress in design specifications were among significant developments.**

***Waldo G. Bowman***

REVIEW AND APPRAISAL of the bridge field in 1940 must begin with the fact that the investment in better bridge facilities was less, by 20 percent, than in 1939. As many bridges may have been built, probably were built, but there was a lack of the large costly structures that swell the contract totals. The $120,000,000 that went into bridges, however, is a substantial sum, although larger annual expenditures are needed if the 2,400 substandard rural bridges are to be eliminated in a reasonable time and if urban bridge facilities are to keep pace with traffic requirements. Nearly six times as much money was spent on streets and roads in 1940 as was spent on bridges, a ratio that is probably too high for the best overall efficiency of the highway system.

### A tragic failure

Neither a reduced volume of work nor the lack of big new projects, however, cut down technical achievement in the bridge field. And this is true despite the fact that the year was marked by the greatest bridge disaster in 25 years. Failure is, of course, never achievement, but out of the lessons learned from the wind-wrecked deck of the Tacoma Narrows Bridge a basis for sounder advance is bound to emerge.

By reversing a trend toward extreme flexibility in suspension bridges, at least until such time as engineers have mastered the principles and learned the idiosyncrasies of dynamic wind action, the disaster at Tacoma Narrows was the outstanding bridge development of the year. Aerodynamic instability was readily agreed upon as the cause of the failure, but these are mere words until they are evaluated in terms of the actual forces involved and the structural details that failed to resist them. These factors are actively under study not only by official investigating committees but by the profession at large. As a result of the failure, elastic models and wind tunnels become a necessary part of the bridge engineer's equipment.

Also as a result of the failure attention was focused on means of eliminating in other flexible suspension bridge decks the disturbing vertical undulations that at Tacoma were the antecedent of disaster. In 1939, systems of diagonal stays, reaching from the roadway at the towers up to the main cables, were installed on the Thousand Islands Bridge in New York and the Deer Isle Bridge in Maine, which successfully reduced the oscillations. On the Whitestone Bridge at New York, damping brakes were tried at the towers, and after the Tacoma collapse these were supplemented by a diagonal stay system, in this case running from the top of the towers to the roadway. Further developments in the direction of rendering suspension bridge decks more stable and rigid are to be expected.

### Longer plate girders

The year witnessed new increases in lengths of plate girder spans. It was only about three years ago that the 200-ft. mark was reached in this country. Now in service is a 271-ft. span in the approach to Cleveland's Main Ave. bridge, and the Connecticut highway department has designed one of 300 ft. for the new Hartford bridge over the Connecticut River.

***Longest spans over the Mississippi River are in the new crossing at Natchez. Both channel spans of this continuous cantilever are 875 ft. between piers. The total length of bridge structure is 4,205 ft.***

With long span girder technique perfected, more and more multispan bridges are of plate girder construction from end to end rather than being an assortment of girders and trusses. Plate construction is also finding favor for the legs of bridge bents, as in the rigid frames used to support the girders of the New Jersey approach to the Lincoln Tunnel and in the novel one-leg bents in Connecticut's Housatonic River bridge. These latter bents, labeled "canopy towers" because of the floorbeam that cantilevers to either side across the top, are of cellular construction like a suspension bridge tower. Both in design and appearance they are an interesting new structural form.

#### Some of the unusual structures

Several other bridge innovations deserve note. In the State of Washington, where hollow concrete box girders have attained their greatest popularity, studies were made of precasting such members, with the idea of laying several of them side by side to form the complete superstructure of short span bridges. In Connecticut, thin precast exposed-aggregate slabs were used to face bridge abutments. And the Missouri state highway department built a steel bridge near St. Louis described as a three-span continuous tied arch. In it the truss-type arch, from which the roadway is suspended, is continuous with the trusses of the adjacent end spans. Since this continuity reduces the stresses in the arch chords, a relatively small tie member can be used.

Among the unusual bridges of the year should also be mentioned the Lake Washington concrete pontoon bridge at Seattle, which was placed in service and met every expectation of its designers, including stability under relatively severe wave action. Also, although the Wichert continuous truss with its pinned quadrilateral end panels, is not an innovation, the fact that Maryland completed three such structures in 1940 is notable. Girder as well as truss spans were equipped with the Wichert articulated end panels. One of the bridges introduced the Wichert design to long through trusses, while on another a Wichert truss was pre-assembled and floated into place for the first time, an operation of some difficulty because of the pinned connections at the supports.

A number of bridges, completed or started during the year, had notable span lengths for their type. At St. Georges, Del., a 540-ft. tied arch was begun over the Chesapeake and Delaware Canal. And at Lorain, Ohio, a 333-ft. double-leaf highway bascule

***One-leg bents are unusual feature of Housatonic River bridge.***

is the longest built for many years, being exceeded only by the 336-ft. railroad bascule at Sault Ste. Marie, built in 1914. At Niagara Falls a 950-ft. span hingeless steel arch was begun, which will exceed New York City's Henry Hudson span, at present the longest, by 150 ft. The 875-ft. cantilever spans in the new Natchez bridge are the longest of any type yet built over the Mississippi River. Finally, according to unofficial reports, Spain completed the concrete arch railway bridge over the Else River, with a record span of 672 ft.

The principle of continuity has been so widely accepted that it is probably accurate to say that the majority of new multispan bridges now embrace it in one form or another. That continuous structures still require a specialist's attention, however, is borne out by an incident in a midwestern state last year wherein a man with the title of county engineer came into possession of a blueprint showing a 5-span continuous girder bridge. For a job he had in hand he needed only 3 spans, which he proceeded to build from the blueprint, leaving off the two end spans. Next he cut one end span loose from the continuous layout "to eliminate expansion joints at the abutment"; both pier supports were put on double rockers. First result was overstressing of one end span and a 6-in. deflection in the other. Final result was a costly rebuilding job. Continuity is not for inexpert hands.

Lightweight bridge decks represent another modern development that is approaching the status of standard practice. The concrete-filled steel grid is the most widely used type, but rise in popularity of the open steel grid deck is even more remarkable in view of its more radical departure from the conventional. First used on movable spans where its light weight is easily translated into dollar savings, the open grid has extended its field to all types of fixed spans, and is now being considered for long suspension spans. In view of the new concern over dynamic wind action the effect of such a deck on lift coefficients will be something to be determined in the wind tunnel. A serious timber deck fire on a bridge at Kansas City, being the first in several years, served to emphasize the progress that has been made in rendering bridge decks fireproof.

Building 307 bridges and culverts of the Pennsylvania Turnpike, which set a new record for an integrated bridge program, provided a preview of what bridge building may be like in the future, when express highways are the rule rather than the exception. A total of 53 of the bridges were concrete rigid frames, and the program afforded opportunity for a careful live load test of a skew span. That the results showed deflections well within computed values and practically no end rotation of the deck is new assurance that the design of skewed frames is on a satisfactory basis.

#### New bridge specifications

Research was not particularly active during the year, but specification development made important progress. Most notable was a revision of the bridge welding specifications of the American Welding Society. Butt-welded tension splices are approved as superior in impact service to cover-plated splices. Also approved are plug and shot welds, and procedures are listed to eliminate the dangers arising from too rapid cooling and the use of thick material in rigid connections. The new bridge specifications of the American Association of State Highway Officials were also practically completed during the year, and will be published soon. New material will cover continuous structures, rigid frames, pile-driving and pile loading.

# Advance in Transportation

**Highway, railway, waterway and airway transport, aided by new construction and improvements, made substantial progress in meeting growing demands**

**V. T. Boughton**

MOST SPECTACULAR among the transportation developments of 1940 was the great increase in commercial flying across the Atlantic Ocean. Such crossings now are on quite regular schedules and are the only way in which a fast crossing for persons or mail can be made. Commercial flying on the overland routes continued its rapid expansion of recent years. To meet the growing acceptance of air transport, the railroads continued to add to their fleets of high-speed, lightweight trains, bringing the total of such trains in service at the end of the year to nearly one hundred.

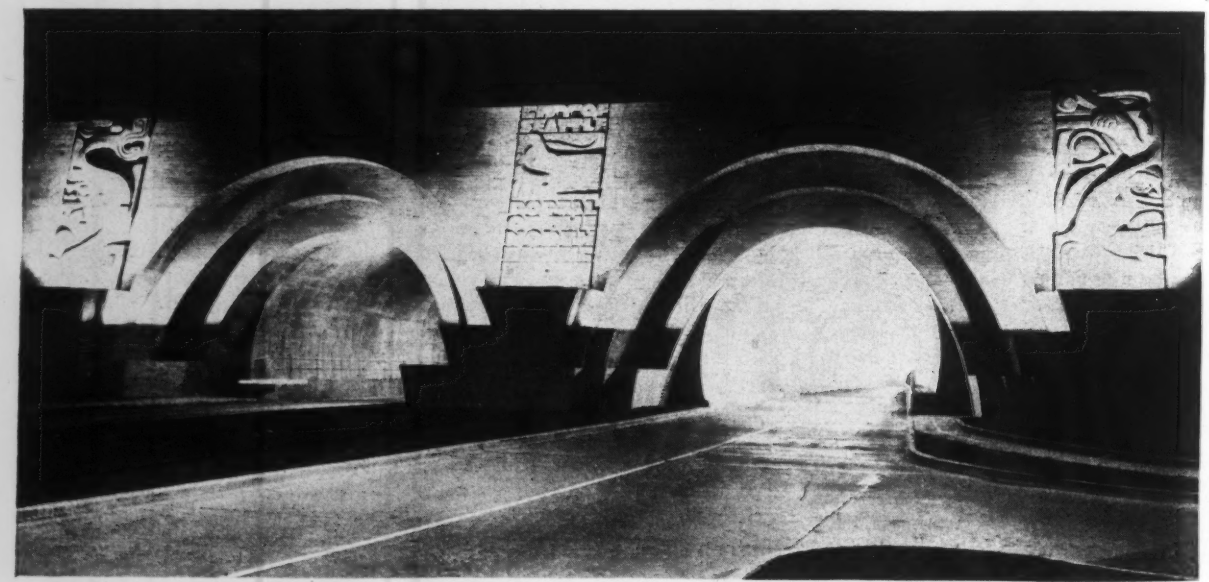
Notable in highway transport was the opening of the Pennsylvania Turnpike, the nation's first long-distance toll highway built for the high-speed movement of both trucks and passenger vehicles.

Most significant among legislative acts affecting transportation was passage of the Transportation Act of 1940, a measure in which Congress set up a national policy of extending federal regulation to all forms of transportation in the interest of equality of opportunity.

### Commerce Act Extended

The Transportation Act of 1940 amended the Interstate Commerce Act to put all common and contract carriers by water, except certain carriers of bulk commodities, under the control of the Interstate Commerce Commission. As a result, nearly all common and contract carriers by rail, highway or waterway are under the supervision of the I.C.C. Though waterway interests objected strongly to being brought under I.C.C. control, their inclusion is expected to be beneficial to transportation as a whole. The act also provided for setting up an agency to make a comprehensive study and to report to Congress on further steps to be taken to put all forms of transportation on an equitable basis with respect to regulation.

Among the recognized obstacles to a free flow of highway transport is the lack of uniformity in size and weight limitations and the spread of state "port of entry" restrictions over truck movements. In many states legislation affecting commercial truck operations was considered during 1940 and some was passed. More is in prospect for the year 1941. Some of this legislation represents a serious attempt to meet problems raised by the continued growth of highway trucking, but part of it is of a punitive nature, designed chiefly to offset some of the inherent advantages of highway transport as opposed to rail transport. Doubtless all this legislation will be covered in the study authorized by Congress. The railroads hope that the study will include the needlessly restrictive regu-



*General Electric Photo*

***Portal of the twin tunnels on the approach to the Lake Washington pontoon bridge, Seattle. Mercury vapor lights are used at the portals while sodium vapor lamps light the interior of the two tunnels.***

lations that now burden their operations, such as full-crew laws and car-limit laws, laws that have as their chief purpose making jobs under the guise of promoting safety.

At the end of 1940, 77,000 miles of road were in the hands of receivers or trustees, a slight decline from last year.

Gross income of the railroads totaled $4,300,000,000 in 1940, which is 7 percent above 1939 and 19 percent above 1930 low point. Their net income was $650,000,000, or 10 percent above 1939. Capital expenditures are estimated at $400,000,000 as against $262,000,000 in 1939. For an understanding of how capital expenditures have been cut since the previous decade, capital expenditures in the years 1927-1930 averaged almost $800,000,000 per year.

Photo by A. F. Sozio

***Cornelius Vanderbilt, pioneer in steamboat navigation and builder of the New York Central R. R., looks down from the facade of the Grand Central Terminal in New York on the new Airlines Terminal.***

#### New railroad construction

New construction continued at a low ebb, only 26 miles of new line having been built during 1940, according to figures compiled by *Railway Age*. Second track work totaled substantially the same amount. Railroad relocations to get lines out of areas to be submerged by flood-control or power dams continued during the year, the larger ones being those of the Southern Pacific above Shasta Dam and of the Santa Fe in the John Martin reservoir area in Colorado.

Offsetting the new construction is the abandonment of 1,300 miles during the year.

How much new railway line construction will be required to serve cantonments, airbases, shipyards and munitions plants is yet unknown, but from the mileage now under construction or specified for approved projects *Railway Age* estimates that the total may be in excess of 1,000 miles, of which half will be required by munitions plants; one loading plant alone will require 160 miles of track and 658 switches.

#### Maintenance expenditures

Maintenance expenditures for 1940 will be close to half a billion dollars, somewhat more than in 1939. Rail renewals are expected to total one million tons, which except for 1937, is higher than any year since 1930; tie renewals also show a slight gain. Deferred maintenance of facilities not directly connected with safety of operation continues to pile up in a manner that is a cause of deep concern to all who give serious thought to the future of the railroads.

Looking ahead into 1941, the shippers' advisory boards estimate an increase of 9.5 percent in car loadings in the first quarter over the same period last year. Ralph Budd, head of the transportation division of the Council of National Defense, believes that an expenditure of ten billion dollars on defense during the year will increase railroad traffic about 15 percent.

#### Toll highways

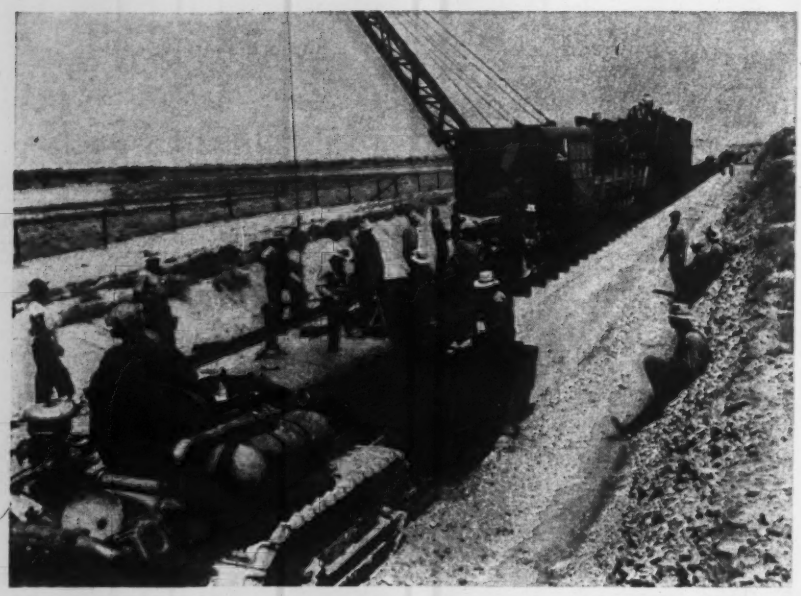
Opening of the 161-mile Pennsylvania Turnpike late in the fall focused attention on the possibilities of high-speed toll highways, and already has resulted in the start of a study of the possibilities of continuing the turnpike to Philadelphia. The total traffic at the end of the year was surprisingly close to the engineers' estimates, although the percentage of trucks, which are looked on as the major source of revenue, was not quite as high as had been anticipated. How much of this is due to deliberate action on the part of large fleet operators in keeping their trucks off the highway while they try to get truck tolls cut is unknown.

The encouraging results from a financial viewpoint have given new heart to those who have been promoting the idea of toll superhighways for several years past. The revenue figures for the Pennsylvania Turnpike, however, will be misleading when used as justification for other projects unless it is recognized that 45 percent of the cost was a federal grant.

The fight against diversion of motor vehicle and fuel taxes to other than highway purposes made encouraging progress during the year. North and South Dakota, Idaho and Nevada passed constitutional amendments during the year prohibiting such diversion, bringing the number of states with such limits to eleven. Similar legislation will be considered in several states this year.

#### Federal aid to highways

Congress in the late summer gave its approval to a new two-year program of federal aid to highways that will carry the work forward until June 30, 1943. Expenditure of $163,500,000 in each fiscal year was authorized, $100,000,000 going to federal-aid systems and the remainder to secondary roads, grade crossing elimination, forest highways and the like. This is a slight reduction over previous years, but not nearly as drastic a cut as some feared when the defense program raised the question of reducing other than defense expenditures. Without doubt the refusal of Congress to cut highway aid was due to a recognition of the importance of highways to military defense, recognition that



***Laying track on the relocated Santa Fe line at John Martin Dam in Colorado. One-third of the ties are hauled ahead on skids pulled by tractors and the remainder are inserted after the rail is laid.***

found expression in authority for the Commissioner of Public Roads to use his influence to have the federal funds spent on roads of military importance.

But Congress did not make any special provision for speeding work on vital defense roads such as access highways to camps and industrial plants. Problems raised by these deficiencies in federal provision for defense road work were discussed in detail in our issue of Jan. 16. All that needs to be said here is that, considering our highways as an element in the national transportation system, the improvement of most roads other than the camp access roads that are held to be of military importance will also aid in meeting commercial needs. However, the present rate of roadbuilding will have to be greatly accelerated if the military system is to be brought up to desired standards within less than ten years.

#### Highways pay their way

In April the final report of the Federal Coordinator of Transportation, Joseph B. Eastman, was made public. It relates to subsidies to transportation, but is concerned chiefly with the question of whether or not the highway users are paying their way through motor vehicle and gasoline taxes. Speaking generally, the coordinator's staff found that since 1927 the highway users have paid their way. Certain types of trucks, notably 1½-ton vehicles, were found to be not paying their way; some others pay too much. In all these computations the one-cent federal gas tax was not included, being considered a contribution to general revenues.

#### Air transport

Scheduled air traffic made its greatest advance in history during 1940, showing an increase of 60 percent over that of 1939. Revenue passenger miles for the year totaled about 130,000,000. Private flying practically doubled during the year.

But as the year closed the demands of military service were giving the commercial companies no little concern. Military authorities were endeavoring to curtail the number of commercial planes being built in order to increase production of army and navy planes, and many commercial airports were being taken over by the army for training purposes. Partly as a result of the latter action and partly to meet growing commercial needs, Congress, near the close of the last session, appropriated $40,000,000 for civil airports.

#### Inland waterways

Completion of the 9-ft. canalization of the Upper Mississippi, from the mouth of the Missouri to Minneapolis, a distance of 658 miles, at a cost of $170,000,000, marks the largest addition to the nation's inland waterway system since the modernized Ohio system was put into service. Work on the Tennessee system progressed during the year, but it will not be opened to 9-ft. draft vessels from the Ohio and Mississippi systems until the completion of Kentucky Dam in 1945. Good progress also was made on the 1,000-mile waterway along the Gulf Coast, the section in Texas being close to completion.

#### Rapid transit

Riding on city transit facilities increased 2½ percent during 1940, which brought the total to over 13 billion passengers, the highest since 1931. Electric surface railways carried about 48 percent, motor buses 30 percent, rapid transit railways 18 percent, and trolley buses 4 percent.

Twenty cities were added during 1940 to those giving all-bus transit service, 12 being a changeover from trolley service and the remainder being new developments.

No major changes in transit facilities took place during the year except in New York where the city completed acquisition of the subways and elevated lines of the Interborough Rapid Transit Co. and the Brooklyn-Manhattan Transit Co., putting them all under the Board of Transportation, which built and operates the Independent System. Late in the year the 4-track Sixth Ave. line of that system was put into service. A little over 2 miles long, it cost, with its equipment, about $27,000,000 a mile, due chiefly to interference with other subways and underground railway lines.

Following unification of the rapid transit lines in New York City the Board of Transportation took down the entire Ninth Ave. elevated line on Manhattan Island, and now is engaged in taking down the Second Ave. elevated railway north of the Queensboro Bridge. South of the bridge it still is used to serve elevated lines in Queens.

Chicago finished the tunneling work on the first section of its new subway system late in the year and is now engaged in the finishing work and in building connections to the elevated lines. A half-mile extension of the Dearborn St. line has been authorized.

# Irrigation and Hydroelectric Power

**Power installations during 1941 will set record of 1,550,000 kw. Legal and other non-technical problems affect future development of multi-purpose projects.**

*J. I. Ballard*

DURING 1941 hydroelectric power installations are scheduled to set a new record totaling 1,550,000 kw. —98 percent in public plants—as compared to a corresponding figure of about 398,000 kw. installed during the past year. The Bureau of Reclamation will account for the largest block of 1941 power installation with 571,000 kw. added to its extensive development in large-scale irrigation and power projects. The year 1940 reemphasized the fact that on multipurpose projects questions relating to the control of power production facilities, the allocation of costs with respect to direct and indirect benefits, and general operating policies have developed modern problems which frequently overshadow those of strictly engineering character. Flood protection which is frequently an element in hydroelectric power development introduces peculiar problems relating to reservoir storage capacity and operation.

A lack of uniformity in the policies of various federal agencies and authorities most directly concerned with water conservation and development complicates the future of hydroelectric power development. An outstanding example of such difficulty during 1940 was the situation on the Kings River in California, where local interests found it necessary to analyze and decide between river development programs submitted by both the Bureau of Reclamation and the U. S. Engineer Department, proposing different plants for the control and output of power generation.

Farthest-reaching and at the same time most uncertain factor affecting the future of private power development occurring during 1940 was the U. S. Supreme Court decision in the New River case, overruling lower court decisions and extending federal authority up the branches and tributaries of navigable streams. The decision is a vital blow to state control and development of water resources and may represent the beginning of federal control over flowing water which had never been assumed to be under federal jurisdiction. The dissenting opinion in the case is particularly illuminating in pointing out the extent to which the decision may be interpreted in future rulings relating to federal control of water resources.

### Installations during 1940 and 1941

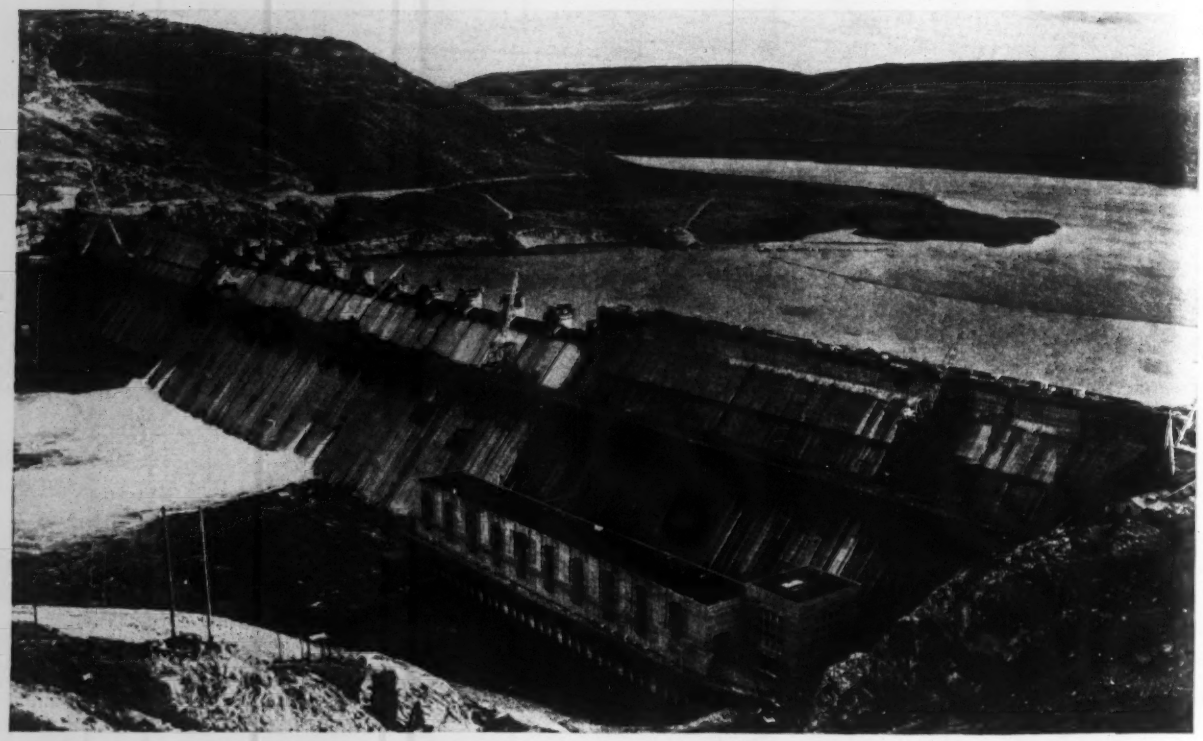
The Tennessee Valley Authority placed in operation the largest block of power to be added during 1940 totaling 138,600 kw. The installation included three propeller type 36,000-hp. units at Chickamauga and one 80,000-hp. Kaplan type unit at Hiwassee. The second largest installation was the 82,500-kw. generator installed at the Boulder power plant by the city of Los Angeles. Other smaller installations brought the 1940 total of public and municipal water power plants to a total of about 265,000 kw.

During the same period the installations of private companies totaled about 135,000 kw., headed by a 66,000-kw. addition to the system of the Arkansas Power & Light Co.

The installations scheduled for 1941, which will produce a new record approaching 1,550,000 kw., are almost exclusively in the field of public development headed by those of the Bureau of Reclamation and the Bonneville Power Administration. Largest single item in the Bureau of Reclamation's power program for 1941 will be the completion of three record-breaking 108,000-kw. generators in the power plant at Grand Coulee Dam. Installation of these units was started in 1940 and production of initial power is scheduled for the current year. Another 82,500-kw. generator is scheduled for operation in the Boulder power plant during the current year for the city of Los Angeles.

The first power output at Parker

***Modern irrigation practice, illustrated by this view of the Contra Costa Canal of the Central Valley Project, includes concrete-lined ditches for water conservation and the economies of pumping lifts for serving higher elevations.***



*In 1941 the initial power installation of 350,000 kw. is going forward at Grand Coulee, including three record-breaking 108,000-kw. generators. The ultimate power development will be 2,750,000 hp.*

Dam on the Colorado River, the diversion structure for the aqueduct of the Metropolitan Water District, is scheduled for the current year with the installation of three 30,000-kw. generators as soon as the powerhouse is completed. This power production facility is being rushed to supply pumping and other requirements in the Salt River Valley area near Phoenix, Ariz., where a water shortage in 1940 placed extra demands on underground sources. The transmission line between Parker Dam and Phoenix has already been completed and during the past season was delivering Boulder dam power which will be replaced with that generated at Parker Dam as soon as the plant is completed. During the current year work will continue on the production of four 75,000-kw. generators which the Bureau of Reclamation will install in the plant at Shasta Dam as soon as that project is ready for power development.

In the South the 1941 program of the South Carolina Public Service Authority calls for the initial installation of 112,000 kw. at the Santee-Cooper project. Units will include four 40,000-hp. and one 13,300-hp. turbines. Ultimate plant capacity will be 213,300 hp. The TVA has scheduled a 90,000-kw. addition to its generating capacity with two units to be added to the power plant at Wheeler dam.

In the Middle West the Central Nebraska Public Power & Irrigation District has indicated a program which will include completion of the 54,000-kw. plant of the Tri-County project on the North Platte River.

Private companies' plans for 1941 include only small additions aggregating 33,000 kw. or about 2 percent of the total hydroelectric installations scheduled for this year.

### Irrigation becomes federal

Irrigation development has become exclusively a federal function, as a result of the cost of the projects now required to develop water at available storage sites and deliver it to land capable of sustaining irrigation agriculture. Impetus for these large current developments, as indicated by the two outstanding examples—the Central Valley project in California and the Colorado-Big Thompson project in Colorado—usually begins with the need for supplemental supplies for land already irrigated, to insure against late-season shortage and an adequate supply during low flow years. Hydroelectric power possibilities form the basis for the following economic study, and the resulting program, if found feasible, usually provides for the immediate needs for "rescue" irrigation, with frequently a reserve capacity which can be applied to unirrigated areas "as needed."

The "as needed" factor affecting the future of reclamation will be influenced by population growth in the region served by irrigation agriculture and the requirements of this area based on economic transportation. During the past few years the limit of freight haul to meet the need of Pacific Coast consumers has been pushed eastward from Nevada until products from irrigated areas in Utah are now being shipped west to market. In the eastern edge of the irrigated agriculture zone, the feeding and fattening of livestock being shipped from western ranges to eastern packing centers has developed an increasing need for feed crops. Sugar beet raising is related to this phase of irrigation development through the feeding of waste products resulting from the production of sugar, and this use will expand

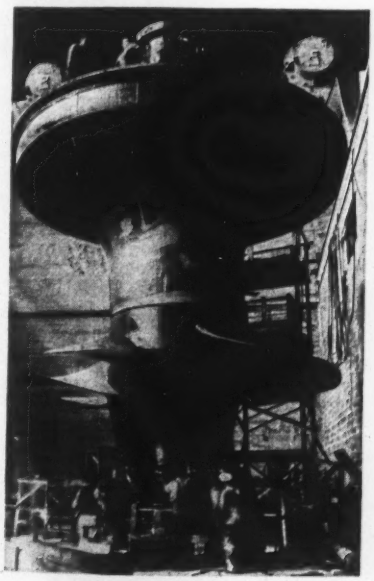
as facilities are developed for drying and preserving these byproducts.

The application of irrigation water to raw land will be a slow process, even where the projects now under construction have made a stored supply available for use. In all areas scheduled for development by the federal agencies comprehensive economic studies demonstrating the feasibility of irrigation including factors of available water, proper land and salable crops, will be the basis for introducing water onto new acreage. The most extensive development now being studied for expanded irrigation is the 1,200,000 acres of land lying in the Columbia Basin in eastern Washington which can be supplied from storage provided by Grand Coulee Dam. During 1940 a comprehensive investigation including field exploration and office study was started by the Bureau of Reclamation to determine the economic feasibility of developing this land according to marketing needs during the coming years.

With funds allocated for the preliminary study of proposed projects, the Bureau of Reclamation continues its investigations on projects ranging in size from small earthern dams to gigantic trans-basin diversion schemes such as the plan proposed in the state of Utah for diverting water from the Colorado River to the Great Basin. During 1940 investigations of the Bureau, carried on jointly with the state, indicated that this project is not economically feasible at the present time.

Irrigation developments of the 1940 type involving large projects covering many streams and even transmountain watersheds introduce ever-increasing problems of water rights. In many cases the resulting legal problems become more serious than those of engineering and include such elements as complicated exchange agreements, transfer of water rights, physical transfer of water and requirements for replacement storage. The Central Valley project in California is an example of legal problems without interstate complications, and the Colorado-Big Thompson project illustrates the replacement method of reservoirs designed to conserve flood flow on a stream to be depleted by required diversion to another watershed area.

Delivery of supplies for irrigation use on the modern project is directly related to power production through the utilizing of off-peak hours to pump stored water for delivery over areas or through conduits above reservoir level. This tendency is one which will find expanding use in the future.



*TVA will carry forward its power program during 1941 with additions to the plant at Wheeler Dam. Last year the unit illustrated was one of three prime movers installed at Chickamauga Dam for the 30,000-kw. generators.*

*In the South the largest power installation of 1941 will be the four 40,000-hp. and one 13,300-hp. turbines for the Santee-Cooper project of the South Carolina Public Service Authority.*

### Conveyance and delivery

The conservation of water in transit continues to be a major interest of those engaged directly with irrigation operations. In addition to conservation of the original supply, such efforts tend to effect a reduction of maintenance costs.

The use of concrete lining in irrigation canals, which has been expanding during recent years, continued during 1940 both for new canals and in old ditch systems. Methods of putting in concrete lining have become standardized as to field procedure with the use of traveling equipment for fine grading, trimming and placing. A modern development has been the use of rubber waterstops in concrete slabs on large structures to provide for settlement and to insure watertightness in case of minor movement of the lining section.

The lining of canals for conservation and reduction in maintenance also has included extensive use of pneumatically placed concrete, particularly in the reconditioning of older ditches where banks are fairly well stabilized and a relatively thin lining is sufficient. A quite recent development has been some experiments with soil-cement as a lining material.

Extensive field experiments conducted jointly by the Bureau of Reclamation and the Asphalt Institute involve the study of asphaltic concrete as a lining material for irrigation ditches.

Another modern maintenance trend is the effort to reduce or eliminate the growth of vegetation along irrigation canal banks. Both chemicals and oil-burning have been used extensively with success depending upon the region and type of vegetation encountered.

With the dedication and initial use of the All-American Canal during 1940, the time approaches when the elaborate desilting works may be placed in operation with results which will be of unusual interest to all irrigation engineers.

# River Development and Control

**Continuation of large projects already under way and the start of authorized new work kept construction activity in river control at a high rate during 1940.**

*Harold W. Richardson*

ACTIVITY in the development and control of rivers was more widespread during 1940 than ever before in the nation's history. From New England to Southern California and from Puget Sound to Florida some flood-control, navigation or power development project was under way in nearly every major river basin. Most of this work was being carried out by the U. S. Engineer Department under various flood-control and river and harbor acts, but a considerable part was under the direction of such agencies as the Bureau of Reclamation, Tennessee Valley Authority, International Boundary Commission, public power districts and private developers of hydroelectric power.

Under normal conditions, this activity would have continued through 1941 at a high rate due to the impetus of flood-control work authorized under the Flood Control Act of 1938, but with the present concentration on national defense such activity is expected to decline sharply this year as current flood-control appropriations are adequate only for continuation of projects now in hand or for inauguration of work that is needed to protect investments already made.

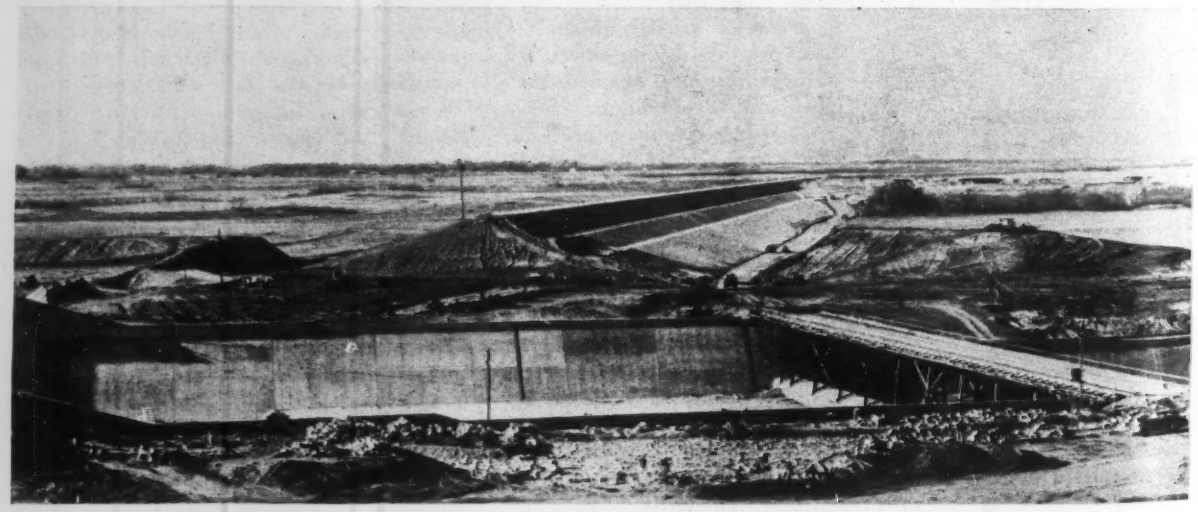
The federal budget for the 1941 fiscal year, ending July 1 next, contains four major items for river control and development totaling $169,000,000. These are: flood control, $70,000,000; Mississippi River, $30,000,000; rivers and harbors, $29,000,000; and Tennessee Valley Authority $40,000,000. This total has been reduced somewhat in the proposed budget for the fiscal year 1942, the corresponding amounts being: flood control, $70,000,000; Mississippi River, $22,000,000; rivers and harbors, $20,000,000; and TVA, $40,000,000. However, TVA is alloted an extra $30,000,000 for power development at Cherokee and Kentucky dams.

### Activities in 1940

Major river improvements for navigation in progress during the year included work on a 27-ft. channel in the Columbia River from Bonneville Dam down to Vancouver, Wash., completion of the 9-ft. channel in the Mississippi between St. Louis and Minneapolis, continuation of channel improvements on the lower Mississippi, and improvement of the waterway in the Tennessee River. Nearly 300 miles of the 650 miles from the mouth of that river to Knoxville is dredged for 9-ft. navigation; the project will be completed with the completion of Kentucky Dam in 1945, the last of the main river dams. The TVA dams also will contribute materially to flood control on that river and on the lower Mississippi.

In the Northwest flood-control activity included considerable local protection and drainage work on the Columbia, Willamette and other rivers, and construction of dams at Mud Mountain on the White River, at Mill Creek on a tributary of the Walla River, at Fern Ridge on the Long Tom River and at Cottage Grove on the coast fork of the Willamette.

Farther south, in the Sacramento basin, Shasta Dam was under construction by the Bureau of Reclamation. It will provide flood control on the main river. The Upper Narrows Dam on the Yuba River, and the North Fork Dam on the north fork



***Great Salt Plains Dam in Oklahoma, one of the major flood-control dams in the Arkansas River valley.***

of the American River were completed. Although these are primarily debris-control structures, they will provide some degree of flood protection. In this territory many levees and channel improvements were under construction, including bypasses and cutoffs between the Feather and Colusa rivers.

In southern California, flood-control work centered around Los Angeles County. Hansen and Prado dams were substantially complete, and the Sepulveda Dam on the Los Angeles River was started. Smaller projects under construction included Fullerton, and Brea dams in this territory. Preliminary work was completed on the Santa Fe Dam, to be built on San Gabriel River, and construction of the dam will start at an early date. Improvement of the Los Angeles River channel, including widening of the river and pavement of bank slopes with grouted riprap, was about 75 percent complete at the end of the year.

The Fort Peck Dam on the Missouri River in eastern Montana, a combined flood-control and navigation improvement project, was completed during the year except for the installation of two of the four gates, the outlet tunnels, and the powerhouse at the outlet of Tunnel No. 1. Because of work on the two gates, it was impossible to store as much water in the reservoir as was desired. However, the water stored during the spring months proved of considerable help to navigation below Sioux City, though the project ran out of water before the navigation season ended. Another flood-control project under way in the Northwest is that at Lake Traverse on the Red River of the North between South Dakota and Minnesota.

In the Arkansas River basin, Conchas Dam was completed at the beginning of the year, Fort Supply Dam on Wolf Creek and Great Salt Plains Dam on Salt Fork reached completion before the year ended, and Canton Dam on the North Canadian was begun. Lower down in the valley, Nimrod Dam on the Fourche La Fave River and Blue Mountain Dam on the Petite Jean River were placed under construction. Norfolk Dam on the North Fork River in Arkansas is ready to be started; bids will be taken Feb. 20. Pensacola Dam, built by the Grand River Authority, of Oklahoma, located on the Grand River in the northeastern part of the state, was completed last year. This is a combined flood-control and power project. Several other projects are proposed in the Arkansas valley. John Martin Dam on the main stem of the Arkansas at Caddoa, Colo., was started last fall.

***Channel improvement work on the Conemaugh River below Johnstown, Pa., carried out by the U. S. Engineer Department, to facilitate the movement of floods past the city.***

In the Missouri River valley, flood-control activities centered around the Kansas River with start of a big dam at Kanopolis on the Smoky Hill River. Harlan County and Turtle Creek projects, the former substituted for the proposed Milford project, are expected to come up for early bidding. At the junction of the Kansas and Missouri rivers, at Kansas City, Kans., an extensive levee project is nearing completion, and improvement of the Kansas River at its mouth is under way. This latter project includes channel dredging and some levee work.

Control of the Red River is concentrated in one large project at Denison, Tex., where the world's largest rolled-earth fill dam, containing 22,000,000 cu. yd., is under construction. The outlet and diversion works are now complete and a good start has been made in placing the fill. This is an Army Engineer job.

In the heart of Texas two large projects have recently been completed, Possum Kingdom Dam on the Brazos near Mineral Wells, and Buchanan Dam on the Colorado above Austin. The top lift is being placed on the huge Marshall Ford Dam, also on the Colorado River near Austin.

Along the Rio Grande in the southern part of Texas work has been under way for years on the control of the river through a system of levees and floodways, designed for the double purpose of diverting water to the fertile citrus lands and for flood protection. At present several construction contracts are nearing completion, and bids will be called for additional work in the near future. The Rio Grande projects are directed by the International Boundary Commission.

In the Mississippi Valley, flood-control work is scattered from the St. Francis in Missouri, where Wappapello Dam and levee construction are under way, and from the Clearwater Reservoir on the Black River in Missouri, to the Gulf of Mexico. Though the main river levee system is substantially complete, backwater and secondary levee construction is a never-ending job.

Substantial progress has been made in flood control in the Yazoo Valley in Mississippi. Sardis Dam on Little Tallahatchie River in the state is practically complete, and work has started on Arkabutla Dam on the Coldwater branch of the Yazoo. Two cutoffs are under construction on the Yazoo River, one at Famosla Dam and the other at Howard Cash Dam. These are to improve flood flowage of the river. Four cutoffs are also being made on the Tallahatchie River.

In the Atchafalaya Basin, work is well under way on the Morganza

***Partly completed setback levee at Clark's Canal Bend on the Rio Grande. Beyond is the reconstructed levee extending along the levee. There was a minor flood in the river when this picture was taken.***

floodway to divert excess waters from the Mississippi into the Atchafalaya. The main levee on the east side of the Atchafalaya River is practically complete, and work is well along on the west levee. A new outlet for the river is being cut through Wax Lake, and this work is also well along. Improvement of the Atchafalaya for navigation purposes has been under way for several years.

In the Ohio Valley, flood control work is divided into two general divisions: local flood protection work along the main stem, and reservoirs in the upper tributaries. Considerable local protection work has been done at Paducah, Evansville, Louisville, Portsmouth, Ironton, Kenova, Huntington, and Wellsville. Plans have just been announced for a big local project at Cincinnati for the protection of the Mill Creek valley, consisting of high concrete walls and a barrier dam. The dam will contain six 1,500-cfs. pumps to handle Mill Creek water when the Ohio is in flood. Numerous reservoirs have been proposed for the tributaries to the lower Ohio in Kentucky, southern Indiana and West Virginia.

***Conchas Dam on the South Canadian River in New Mexico is 220 ft. high and 1,160 ft. long, flanked by four miles of earth dike. The reservoir that it forms will hold 600,000 acre-ft., of which 200,000 is for flood storage.***

#### On the upper Ohio

On the tributaries of the upper Ohio, flood storage reservoirs are under construction at Loyalhanna, Crooked Creek, Mahoning, Tionesta and Youghiogheny. The Tygart project on Tygart River was completed some time ago. All of these dams have a bearing on flood protection for Pittsburgh, although complete protection for the city will depend upon extensive local walls and levees, none of which has been built.

Dams have been proposed at French Creek, Allegheny, Red Bank Creek, Conemaugh and West Fork locations. At Johnstown, flood protection has been concentrated in increasing the capacity of the Conemaugh River channel, particularly in the stretch immediately below the city. It was the backing up of waters in this congested section of the channel that did so much damage in the flood of 1936.

Flood control of the Susquehanna River includes construction of three dams on the upper tributaries at Arkport, Almond and Whitney Point. These projects have been supplemented by considerable local protection work, particularly at Kingston and Wilkes-Barre.

In New England, flood control is concentrated in the Connecticut and Merrimack basins and includes projects at Knightsville, Birch Hill, Surry Mountain, Blackwater and Franklin Falls. These are all Army Engineer dams. The state of New Hampshire has completed a flood-control dam at Pittsburgh at the headwaters of the Connecticut. Extensive levee and other local protection work has been done throughout these two valleys, particularly at Hartford and Springfield.

#### Work will continue

There is no doubt but what flood control activities will be carried on for years to come. The nation has awakened to the tremendous economic losses caused by floods, and has put flood prevention on a basis corresponding to highway building, an indispensable public improvement. The defense program may delay some projects, but will speed others vital to the protection of important industrial areas.

# The Year in Research

**Broadening horizons for the civil engineer indicated by 1940 advances in the fields of structures, cement and concrete, highways, hydraulics, soils and structural welding**

*N. A. Bowers*

RESEARCH is broadening the field of the civil engineer and putting more emphasis on specialization. Where relatively few subjects had to be covered before, more branches are continually appearing and information is accumulating so rapidly that one who would keep abreast of current knowledge in even a few related specialties finds his time fully occupied.

This situation puts emphasis on the need for more effective recording of the results of research—some form of clearinghouse or index to which there could be speedy reference and whence comprehensive information could be obtained. Information from such a source should have the limitations of its application clearly stated to avoid lost time and risk of error. Results of laboratory work may be lost or may be misleading if proper interpretation is lacking; limits must be known. (Witness recent specifications for a welded structure using steels later found to be unsuitable for welding.) In applied research, which is directed toward developing new methods or improving results, objectives may be more influenced by conditions in the field than by principles developed in the laboratory.

A summary of 1940 research can list progress in many lines and important advances in a considerable number. In some respects the concentration of attention on preparedness and national defense has diverted time and funds that otherwise would have gone into research. Offsetting this has been the higher premium which the present national emergency has placed upon obtaining better materials and speedier operation. The net result is that research continues to occupy a dominant position.

### In the structural field

Tests of large-scale models of steel structures are being made to determine the strength of and stresses in compression members with perforated cover plates instead of lacing bars. Tests also are being made on continuity in riveted building frames and to learn more about the crippling of beam webs and the strength of short columns. Studies are under way on plate girders to determine stress distribution in riveted splices. Large-scale model tests are being made as a joint study by the U. S. Navy and the American Institute of Steel Construction on steel rigid-frame knees of various shapes. A very comprehensive study extending over some two years on the preparation of structural steel surfaces for painting, was completed last fall; results are to be printed in pamphlet form soon.

### Better photoelastic analysis

An important improvement in photoelastic analysis of stresses in three-dimensional models has been developed at Ohio State University. Heretofore such models have been sliced into thin sections for examination by the usual photoelastic method for two-dimensional models. The improvement consists of "slicing" the model by a thin beam of polarized light. No conventional analyzer is employed, but the scattering of light by the model itself in directions perpendicular to the original beam produces the visible effects. This method does not injure the model and the same one may be used repeatedly. An oscillating machine (Ohio State) is being used in the study of impact in bridges of various types. After determining damping factors and verifying accuracy of theoretical analyses, it is used in interpreting tests made with service loads.

A result of applied research in steel structures noted in 1940 is the increased use of rigid frames, ascribed to better appearance and lower overall cost (as compared to ordinary truss construction) for hangars, armories, auditoriums, etc. Another structural steel item in applied research is the omission of paint from contact surfaces in riveted connections. Without paint the bond is 5 to 15 percent stronger than when paint is used.

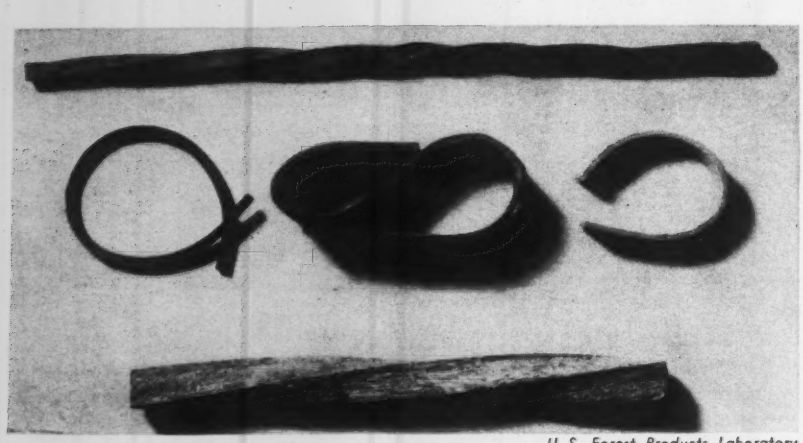
A precision testing and metal working machine with a 3,000,000-lb. capacity was installed during the year by Aluminum Research Laboratories for full-scale tests of beams and girders and for the investigation of the principles of working metals under extreme pressures. Response of buildings to earthquake shocks is being studied at California Institute of Technology to develop adequate building code provisions.

Tests on semi-rigid properties of riveted beam-to-column connections, using top and seat angles, as well as on the behavior of columns with end moments acting as a part of frames, have been going on at Lehigh (sponsored by Amer. Inst. of Steel Const'n.). Extensive studies are also being made in both static and dynamic field tests of full-size box-girders and laboratory tests to failure of box-girders. This project (largely with welded girders) is directed toward improving design methods for crane-girder construction.

### Cement and concrete

A long-time study of cement performance in concrete, started early in 1940, is being directed by consumers and manufacturers working jointly through a committee of 12 on studies to cost some $350,000. Portions of the program are allocated to various parts of the country; results are expected to be better coordination of research activities and more rapid progress toward the maximum in concrete performance.

Of widespread interest are the results of tests, reported early in 1940 by Stanton (California Highway



U. S. Forest Products Laboratory

***Plasticized wood which can be bent, twisted or compressed, after being soaked in a solution and dried at 212 deg. F. When cooled, it resumes its original hardness, but retains its altered shape unless reheated.***

Commission), showing how disruptive expansion of concrete occurs when certain aggregates are used with cements high in alkali content. This finding provides the answer to some puzzling concrete disintegrations; it has been checked by results in other states and it is now believed that the same destructive reactions may be anticipated with other types of aggregates than those included in the California tests. The California studies show that alkali in the cement (sodium and potassium oxides) is an active factor in disintegration only in the presence of certain deleterious minerals in the aggregate.

To save steel, higher stresses are being used for concrete reinforcement. Because bond strength must keep pace with steel stress, this subject has been studied intensively at several universities, by the Portland Cement Association and by the National Bureau of Standards. Structural behavior of bridge- floor- and road-slabs under load is receiving special attention.

A usable, quantitative tool for studying the durability of concrete is promised by studies of the dynamic method for determining the modulus of elasticity of concrete.

### Highways

Cement-treated road bases as a foundation for relatively light wearing surfaces took a great spurt in 1940 and further work is being done on pit-run materials to which portland cement is added in a central mixing plant with only sufficient moisture for optimum compaction.

Scaling of concrete pavements, after the use of chlorides for the removal of ice, has become an important problem on which at least seven states have studies under way. In one set of tests conclusions are that resistance to this type of disintegration can be obtained by grinding the cement with certain resins, oils or stearates. As little as 1/20 of one percent of such material in the portland cement is effective. Good results have also been obtained by the use of a blend of natural and portland cements.

An oval test road in California is being used to determine the relative thicknesses required in different types of stabilized base materials to give satisfactory service with low-cost road types. Test roads and experimental pavements on main highways are under study in a number of states.

After two years of work, Iowa State College now has compiled data on two cars each driven 65,000 mi. over gravel surfaces and two driven like distances on concrete pavements, to show the effect of road surface upon the various elements of operating cost. These data are now being analyzed in cooperation with the Public Roads Administration.

In studies of human elements in highway safety with reference to the legibility, size, form and color of roadway signs in both natural and artificial light, Iowa State is cooperating with the American Optical Association. Magnitude and distribution of pressures transmitted from a loaded truck wheel through flexible pavements are being measured by means of small carbon piles and field measurements of the settlements which determine the values of the "settlement ratio" are being continued.

Award of contract, late in December, for a materials testing laboratory for the Oregon State Highway Commission bespeaks current emphasis there on the need for continuing and extending highway research. Oregon completed recently an extensive series of studies on suspension bridges of short span for modern highway loading. Studies of skid-resistance on various pavement surfaces is being continued, supplementing work on which a preliminary report was published a year ago. Further studies of the effects of joint spacing in concrete pavements are under way from which much information is being gleaned on seasonal movements at the joints; the effect of temperature and moisture changes on such movements is being observed.

### Hydraulics

Open-channel models for hydraulic studies have become routine design procedure and many agencies are engaging in this work. Despite absence of outstanding developments during the year, many highly useful investigations have made progress. Unlike some of the fields in which there is less coordination, a comprehensive coverage of hydraulic research under way is given in a bulletin published semi-annually by the national hydraulic laboratory operated by the Bureau of Standards.

With hydraulic studies reaching a more static state, as compared to years when the science and practice were developing rapidly, there has been a trend toward development of the fundamental aspects of hydraulics in relation to the same phenomena in other fields. By some this is viewed as a trend toward recognition of the broad science of "fluid mechanics" in which hydraulics will be merely a special case.

Some laboratories have turned to studies of the more fundamental relations such as turbulence, the limitations of the various kinds of flow and the fundamentals of flow in open channels. In sediment transportation, studies are being made of suspended sediment in open channels and special attention is being given to devices for sampling and analyzing suspended sediment carried by streams, this latter spurred by interest in soil conservation.

Air as the fluid in place of water

has been found adaptable, rapid and accurate for analyzing certain types of pressure conduit problems. Air was used to determine the efficiency of various designs of jet pump diffusers in connection with hydroelectric design. Studies of controls for high-pressure outlets through dams have been continued by the Bureau of Reclamation and the design of needle valves has been modified to eliminate negative pressures and consequent cavitation.

In studying the effect of suspended load on velocity distribution (Calif. Inst. Tech.) it was found that the presence of a small load actually increases the velocity of flow. Other studies of sediment in suspension indicated that its movement may be subject to control so that incoming sediments can be routed through the body of a reservoir.

Investigations by the Mississippi River Commission made extensive use of models in studying shoaling and problems affecting wave action, breakwaters and tidal movements. One of the Mississippi River models represents a stretch of 600 river miles.

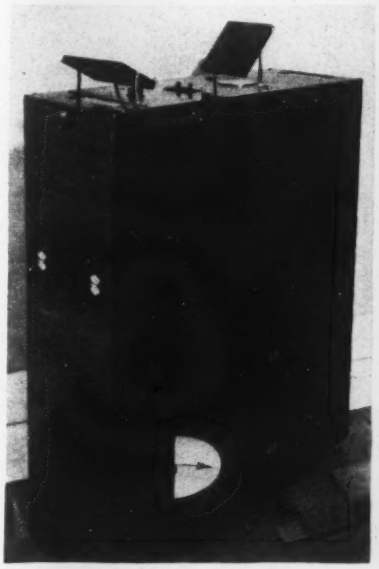
An electrical device was developed for instantaneous registering of wave heights and pressures in the study of wave force against breakwaters. Sonic-sounding apparatus is being used in studying the rate of bed load movements and in the recording of bed configuration changes in rising and falling stages. Attention is also being given to runoff coefficients for small, low-lying water sheds; to superelevation in curved channels and to the effects of exit-channel-floor elevation on spillway discharge.

To study the distribution of flow in narrow open channels (Mass. Inst. of Tech.) bentonite has been introduced into the flowing water and the solution allowed to pass through polarized light. The resulting colors permit the determination not only of flow lines but also, it is hoped, of velocity distribution. This is only a small part of a long-time study of flow in open channels under way in this laboratory.

### Soil mechanics

Principles of soil mechanics, as they become better known, are being applied to an ever-increasing percentage of fill and embankment works of all sorts. This growing interest has spurred studies of sampling and testing methods and has resulted in the publication by Engineering Foundation of a "Preliminary Draft of the Report on the Art of Obtaining Undisturbed Samples of Soils" which reviews many devices and methods developed here and in foreign countries. Design of earth dams probably will be influenced by cooperative investigations (War Department, Harvard and Massachusetts Institute of Technology) of stress deformation and strength characteristics of soils, by triaxial tests. Studies of soil sampling methods by Dr. Hvorslev (Harvard) have shown that most methods of obtaining "undisturbed samples" produce very serious disturbance of the soil. His findings stress the importance of very thin metal in sampling tubes and cutting edges 1 to 2 percent smaller than inside tube diameters. Shortcomings of soils laboratory tests are being recognized with the result that field compaction tests are gaining popularity. An outstanding example of the practical application of soil mechanics during the year was the extensive investigations in connection with the design of the third set of locks for the Panama Canal.

A triaxial compression testing machine weighing more than 13 tons is being built, the Bureau of Reclamation announces, to study shear strength in concrete. The machine will be able to exert 125,000 lb. per sq. in. in both lateral and longitudinal directions and will be sensitive to 25 lb. per sq. in. over its entire range.



***Earthquake analyzer developed by the Bureau of Reclamation for the study of earthquake forces to be used in the design of some of the structures built by that organization.***

Pore pressure (referred to by some as uplift and by others as hydrodynamic stress) has come to be recognized as a major factor in stability of earthen dams and fills. Much work has been done in pore pressure measurements on sealed- as well as on free-draining specimens. Some methods of determining optimum moisture content permit development of alarmingly high pore pressures in high dams, and a more comprehensive design and control method devised by Dr. Brahtz (Bureau of Reclamation) sets up a maximum allowable pore pressure at any time during construction.

### New data on welding

During 1940, the usual valuable contributions from Europe in welding research have not materialized. In this country, however, comprehensive work has been done at the University of Illinois financed largely by the Chicago Bridge and Iron Co., the U. S. Public Roads Administration and the U. S. Navy. Some $41,000 has been spent to date; the budget for 1941 is $18,000.

In 1940 results were announced on a long series of tests on fatigue strength of butt welds made with covered electrodes in plain carbon and low-alloy steel; fatigue strengths with the low-alloy steels were a little higher.

The strength of butt and fillet welds made with covered electrodes was about 20 percent higher than when using bare electrodes tested about 10 years ago by the structural steel research committee of the American Welding Society. Investigation has begun to determine the reliable weldability of certain steels; that is, to find whether they become brittle as the result of thermal heating and cooling cycles incidental to welding.

In a report of studies in Belgium, it was announced that tensile shrinkage stresses up to the yield value may be expected in the vicinity of an arc weld in steel made without preheat. Contrary to popular belief, the highly stressed zone under such conditions is narrower with fast (cool) welding than with slow (hot) welding. Question remains whether the width of the highly stressed zone or the deepness of the stress gradient has any influence on service behavior. A signifi-

cant aid in studying this general problem will be Professor Norton's X-ray camera (Mass. Inst. of Tech.) with which shrinkage stresses may be measured without cutting up the welded part.

Research has shown that the oxygen-cut edges of structural steels may be softened free from cracks by preceding or following the cutting torch with a preheat or postheat torch which retards the cooling rate and thus prevents hardening.

Two noteworthy research developments during the year have been (1) pulsation welding in which periods of zero power are interspersed between pulsations of welding power and (2) spot- and seam-welding machines using the principle of storage of energy in condensers or inductances. A number of subcommittees are studying a series of related problems in the welding of high-alloy (stainless) steels. A new brazing process has been developed utilizing a low-melting, high-aluminum brazing alloy and flux for joining sheet aluminum into intricate parts in which welding would be impossible owing to melting and collapse of the parts. These brazed joints have excellent strength and corrosion resistance. The rapid assembly this new method permits is an important aid to large-scale production programs.

### Various materials studied

The adhesion of bitumen to aggregate is receiving attention from several research organizations; endeavor is being made to find treatments that overcome the so-called "hydrophilic" characteristics of the aggregate used with bitumens.

In aggregate grading, increased attention is being given to proportioning and larger proportions of the finer sizes are being used. Corollary studies deal with means of eliminating soft and otherwise deleterious particles.

Present indications suggest early success in developing a water-resistant asphalt and progress is being made in field methods for determining correct amount of liquid asphaltic binder required for dense graded road- or plant-mixed construction. One new method, the "kerosene centrifuge equivalent," is somewhat similar to the well-known centrifuge moisture equivalent for soils. A combination of mineral aggregate and liquid asphalt is now being sprayed or blown by compressed air (the so-called "pneumastic process") on slopes of highway cuts to prevent erosion. Very thin layers can thus be placed and the treated shell can be built up over any sort of irregular contour.

Studies of the effects of temperature on the properties of metal have been continued under the sponsorship of the American Society of Mechanical Engineers and a new book has been published by the Alloys of Iron Research entitled "The Alloys of Iron and Chromium, Vol. II."

An important advance in measuring "hardness" of metals has been made in development of the Knoop indentor, recently tested by the Bureau of Standards, which extends the range of materials whose indentation numbers can be obtained, to include glasses, crystals, enamel coatings and others not previously subject to such tests. This advance affords new aid to research workers in various fields.

Numerous tests are being made on different heats of carbon, silicon and several low-alloy steels to determine the compression stress-strain characteristics in relation to the tensile properties. A highly sensitive electric strain gage, capable of measuring strains over a 1-in. gage length in four different directions simultaneously, developed by de Forest (Mass. Inst. of Tech.) is an important contribution to the technique of experimental stress analysis.

The efficiency of soldered sleeve joints in seamless copper tubes subjected to various temperatures has been used as a basis for standards expected to result in more effective use of copper tubing in water systems.

Fissures in railroad rails, batter in rail ends and continuous-welded rails, are under investigation at University of Illinois with prospect for improvement in rail specifications. Welded joint strengths almost, if not quite, equal to the original rail are being obtained. Studies of stresses in reinforced concrete bridge slabs under concentrated loads are now in their fifth year at Univ. of Illinois, under Prof. Richart.

### General

Aerodynamic instability in slender suspension bridges was so emphasized by the collapse of the Tacoma Narrows Bridge that this event has become a milepost in the history of suspension design. Wind tunnel research will no doubt increase as a result of the failure.

A new computation for estimating normal and shear stresses in gravity dams from combined water loads and earthquake acceleration has been devised by the Bureau of Reclamation. A torsion pendulum apparatus is being used to study the action of structures subjected to the ground motion of recorded quakes. Another pendulum device has been built to study the action of structures when stresses exceed elastic limits of the steel.

### Beach erosion studies

Investigations are being made by the War Department's Beach Erosion Board on waves of translation and on oscillatory waves to determine relationships between wave height and water depth as well as the effect of wave action on shorelines. Laboratory work is being done on the rate of abrasion of beach materials and on the settling velocities of beach sand as found in nature. Along the Gulf of Mexico and on the Atlantic coast, measurements are being made periodically to obtain data on the rate of corrosion of steel sheet-piling in these different locations.

Synthetic resin treatment of wood has continued at the Forest Products Laboratory where the cell wall structure of veneer has been impregnated and plasticized to permit formation, at low pressures, of a tightly compressed, laminated wood with high mechanical properties. This product is moldable to double curvature giving an extremely smooth surface and a high resistance to swelling and shrinking. Wood soaked in a concentrated solution of urea and then dried is found to be plastic and capable of being bent, twisted and compressed, while still dry, at temperatures of 212 deg. F. It resumes normal hardness and rigidity when cooled, but retains its altered shape unless reheated.

An experimental wind-power plant will soon be constructed near Hubbardton, Vt., following several years of study on use of wind for electrical generation. Participants in the new plant include General Electric, S. Morgan Smith, California Institute of Technology, Guggenheim Research, Massachusetts Institute of Technology, the Weather Bureau and Harvard University. Plans call for a plant to generate 1,000 kw., under full load, for the Central Verment Power Service Corp.

# Progress in Construction Practice

**Pre-assembly cantonment construction, floating methods on bridge erection, new tunneling record and elaborate concrete plants at major dams highlight construction advances.**

*Hal W. Hunt*

SPEED has taken the spotlight in construction, spurred by the defense rush to get the army housed, the factories under cover and the airbases, shipways and access roads into service. Result has been new methods, improved machines, and most of all effective cooperation of the buyer of construction with the engineer, the constructor and the manufacturer.

Barracks construction was a distinguishing characteristic of the year, and the way was paved for rapid progress when both Army and Navy adopted basic units and similar design for all structures throughout the country. Builders followed with prefabrication of most of the lumber, usually at temporary shops adjacent to the work, and pre-assembly of building wall frames which were lifted into place. At several camps, foundation holes for the frame buildings are made with a power auger mounted on a tractor or truck or by a hole driver operating somewhat as a piledriver with the excavated earth encased in an open pipe and ejected by air or steam pressure. Heavy grading equipment finds extensive use at many camp sites and at one point a contractor is swamping out brush and trees with a heavy tractor equipped with V-bulldozer blade and a vertically adjustable overhead bar which pushes the trees over while the blade tears them out by the roots.

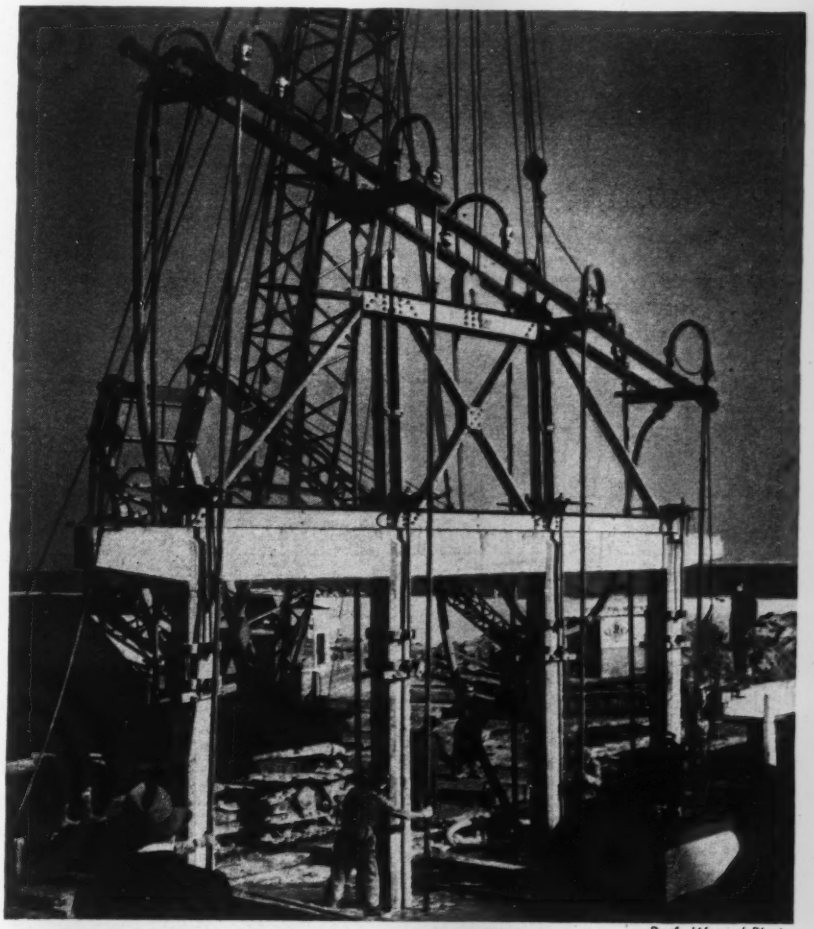
### Some unusual jobs

New in bridge erection schemes is use of a falsework truss erected on a car float and moved into position between piers, then temporarily supported on the pier caps while the main truss members are erected over its top chord. On the same bridge, Ludlow Ferry over the Potomac below Washington, a 275-ft. span Wichert truss was erected on a car float on falsework, then lowered to the pin connections of the rhomboid end panels.

At Krotz Springs, La., a railroad bridge over the Atchafalaya River was altered and extended by moving an existing 300-ft. simple span 720 ft. endward and replacing it and filling the gap with a 444-ft. anchor span and two 138-ft. 9-in. cantilever arms. The old span was rolled out and part of the new put in place with only slight delay to the trains.

Pile shells were jetted successively deeper in the order they would later be driven in individual clusters on a Rockaway, L. I., railroad elevation job. This jetting to variable depths made the driving required and the bearing value obtained about equal for all piles when driven to a common top elevation.

In Chicago, the Monadnock Block, an early skyscraper, has been underpinned through Chicago's unstable



R. A. Wurgel Photo

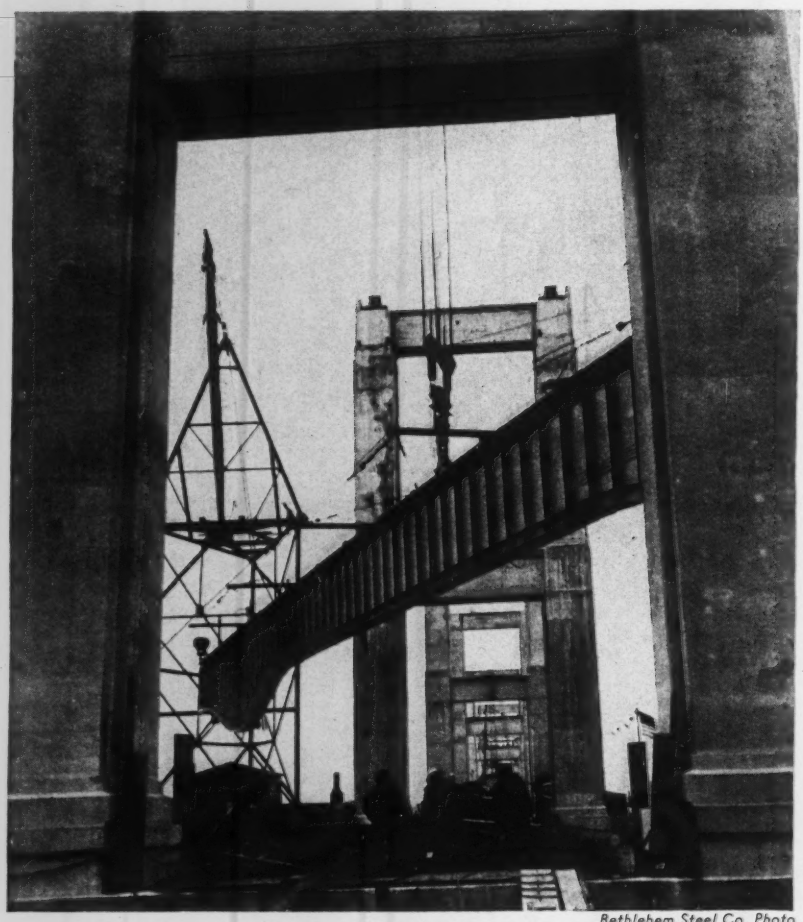
***Every two hours this 2½-yd. crane with 60-ft. boom and special lifting and jetting arrangement pulled out a 40-ft. bent with four 28-ft. piles, moved it back 250 ft. and jetted it down to support the Coney Island, N. Y., boardwalk in a new location.***

clay to prevent subsidence due to subway construction. Existing piers are picked up on a grillage with needles cut into the old brick piers or attached to steel columns. A caisson opening is made through the mat and a 5-ft.-dia. Chicago well caisson sunk about 60 ft. to hardpan, loss of ground being prevented by forcing the caissons out into the clay by jacks and wedges.

At Perth Amboy, N. J., the world's longest (260-ft.) and heaviest (198-ton) girders were raised into position on piers 135 ft. above the Raritan River by a 125-ton double-boom stiffleg erection derrick on the structure and a 75-ton derrick on a barge-mounted tower. Because such a long girder is relatively limber a special system of hog ties was used to brace the top flange during erection. This consisted of four outrigger I-beams about 22 ft. long, with 1-in. dia. cables stretched around the ends of the beams and attached to the ends of the girder. The long girders were shipped by special train and covered the length of five cars, though the weight was carried on only two. Due to vertical clearance limits the lower portion of the 21-ft.-deep section over the pier had to be attached in the field.

At Merriman Dam, present head of the Delaware Aqueduct, two 15x38-ft. concrete exploratory caissons, followed by 18 similar ones 10 or 12x45 ft., were sunk through boulder-filled material by hand excavation, largely in free air to form a cutoff wall for a 340-ft.-high earth-fill dam. The exploratory caissons were located in the deeper part of the work and were pumped continuously during the rest of construction, lowering the water level and reducing the compressed air work required. Two of the caissons lodged part way down, even heavy top loading and complete excavation under the cutting edge failing to start one of them. Final success was attained by excavating along the sides almost to the bottom of the caisson, no evidence being found to support the theory that rock had gouged into the caisson sides to prevent movement. An 18-in. design width between caissons supplemented by an 18-in. deep keyway in the end of each box was excavated by underpinning methods, using air pressure where required to keep out groundwater. They were filled with concrete to complete the concrete cutoff wall.

The tallest bridge piers in the U. S., which will support the Pitt River Bridge over an arm of the Shasta Reservoir, were erected partly by use of builders' elevator and hoist equipment. Platforms were provided above the finished concrete by use of old railroad rails on end in the previous lift as supports. Concrete was distributed by buggy from this platform.



Bethlehem Steel Co. Photo

***At Perth Amboy, N. J., a 260-ft., 198-ton plate girder is lifted to position.***

### Advances in earth handling

The earthmoving and mixing equipment, which has been developing rapidly in the past few years, has had a definite effect on the design of structures and has made practicable the use of soil for many applications previously requiring more expensive materials. Significant advances in mixing and soil stabilization were made on the Washington, D. C., National Airport where a cementless "soil concrete" base of pumped sand and gravel was made by the addition of a small amount of clay binder from the upland part of the port and mixed by heavy cultivators and discs, then rolled by pneumatic-tired equipment. Soil-cement has been used for runways at some of the Army's airfields, a rotary tiller of the garden variety being used for much of the mixing of the portland cement with selected soil.

On California's Hansen Dam 14,700,000 yd. of earth was moved by 15 two-wheel, rubber-tired tractor units powered with 160-hp. engines and drawing 25-yd. carrying scrapers. This equipment moved as much as 26,000 yd. of material in a 22½-hr. day. Average speeds, on the level, for the units was 13 mph. loaded and 17 mph. empty with a haul of about one mile. The same equipment is now being used on the 22,000,000-yd. Denison Dam in Oklahoma.

### New equipment progress

Diesel engines continue a steady advance in use and are now available for almost any operation. Fluid couplings between power and driven units have passed from the experimental stage to standard equipment

on many machines, assuring shock-free operation and full torque efficiency when starting. Pneumatic-tired units in all classes of tractors, scrapers and other material handling equipment have continued to increase in size and number.

New central-mix bituminous plants feature pneumatic-tired mounting of component parts with special controls and dryer units to assure uniform proportioning of all material and drying without overheating. In permanent hot-mix asphalt plants the trend is to electrical heating for various parts of the plant, with oil burners used in the dryer drums.

A new concrete spreader for paving features a traveling blade which moves the concrete forward as well as spreading it laterally. The screw-type spreader, brought out last year, is now available for use on almost any width lane. Pavement vibrators, full width of the slab, are being used more widely, either attached to the spreader, if one is used, or to the finishing machine. A development on concrete paving work has been the use of pneumatic hammers for driving form pins, especially in hard soils.

Truck-mounted concrete mixers have innovations in door arrangements to keep them tight and clean. Several makers have high discharge models, some loading through the rear door, to permit discharge into high hoppers or distribution over large areas. Eight-yard truck mixers are in use hauling from commercial plants in New York City.

To facilitate shearing of asphalt from the brick surface after flushing the hot material into the cracks, a mixture of 64 percent water, 31 percent calcium chloride, and 5 percent starch has proven an excellent separator. To keep the solution away from the sides of the brick where it would prevent adhesion, a wood roller device with a rubber sponge covering is moistened with a controlled amount of solution which is transferred to the brick surface.

Hopper bottom cars and other bulk cement handling devices are being increasingly used with contractors definitely favoring the bulk cement but not assured of adequate equipment in good operating condition in all areas. Special devices designed for handling paver requirements of bulk cement are appearing on many jobs.

Elaborate and fundamentally different plants have been erected by contractors to produce and place the large quantities of concrete required for major projects. At Shasta Dam in California 5,700,000 yd. of concrete is being placed by seven cableways up to 2,670 ft. long radiating from a 460-ft.-high central tower to individual traveling tail towers. These cableways fan out over an area of 1,050 x 3,500 ft., covering the entire dam and powerhouse. At Shasta a 9.6-mile-long, 36-in.-wide belt conveyor system carries 1,100 tons per hour of aggregate to the mixer plant at a speed of 550 ft. per minute. There are 26 conveyor flights varying in length from 850 to 3,240 ft. depending on the grade which ranges up to 25 percent. Each flight is driven by a 200-hp. motor except four downhill flights where regenerative braking is employed.

On the 2,000,000-yd. Friant Dam, also in California, two hammerhead cranes and two revolving derricks operating on a high trestle will place the concrete. Mechanical cooling is provided and a pumicite admixture used with the cement to slow up the setting and reduce the rate of heat generation in the concrete.

TVA uses full revolving derricks at its three major dam construction operations—Kentucky, Watts Bar, and Cherokee. At the latter, built as a defense project to supply power for aluminum manufacture, 745,000 yd. of concrete will be placed in a 20-month construction schedule; work began on July 31 and concrete placing was underway Jan. 6 from new 4-yd. cranes operating on a 90-ft.-high trestle.

#### Form development

Absorptive form lining tests have been so favorable that the Bureau of Reclamation has specified use of such material on 2,000,000 sq.ft. of concrete surface where smooth finish is important. Some states are also requiring its use for special building work.

Friant and Shasta dams are using a cantilever form panel that eliminates struts and ties from the space where concrete is to be placed. TVA continues to use panels with the top held by tension-compression struts at a 45-deg. angle.

A subaqueous vehicle tunnel at Mobile includes a 2000-ft. tube length which was built in seven sections, floated into place and sunk in a prepared trench. Watertight steel shells 30 ft. in dia. were assembled by welding on launching ways, and most of the concrete was placed after the shells were in the water.

#### Tunneling

In Chicago an innovation in tunneling the area's blue clay is to push ahead with wall plate drifts, set the plates and then carry a top heading under the protection of arch ribs resting on the wall plates. Plumb posts are installed in the side drifts and the bench then excavated in two or three steps.

Another advance in tunneling is the use of low-bed drill carriages in tunnels formerly considered too small for such equipment. Many diesel engines are now working in tunnels throughout the country. The overhead shovel has been adapted to tunnel work as a mucking machine. Truck-type concrete mixers mounted on cars act as transfer containers and agitators for some of the Delaware Aqueduct work. The concrete pump is in use in several places on tunnel lining operations.

World's record advance in 31 successive days jumped back and forth between New York, Delaware Aqueduct and the Carlton Tunnel at Cripple Creek, Colo., where it now rests at an advance of 1,879 ft. This was made in a 10x11-ft. tunnel, driven through hard granite from a single portal heading.

Progress in structural welding is illustrated by a 23-story nurses' home at the Medical Center in Jersey City, N. J., which has 20,000 lin. ft. of welds on 2,200 tons of steel. Many new welders are on the market and most construction machines proudly boast "all welded connections."

Flame cleaning of structural steel with oxyacetylene equipment has been found highly efficient and economical for descaling and dehydrating the surface preparatory to painting. Portable steam-cleaning units are being used for such preparatory work on San Francisco-Oakland Bay Bridge which is worked over on a five-year schedule by a crew of 45 men.

In California a new use is being made of sectional corrugated culvert plates in construction of shallow filter bed inclosures. They have the merit of quick and easy assembly and are said to be rigid enough to stand without stiffening up to 40 or 50 ft. in dia. and 3 ft. high.

# On the Business Side of Construction

**Negotiated fixed-fee contracts, wholesale unionization, preponderance of big jobs are some of the things the defense efforts have turned up to change the complexion of contracting.**

***Robert Colborn***

DEFENSE WORK last year was still a fairly small fraction of the total of construction. But it was the dynamic fraction, and it dominated the thinking of the industry by virtue of the new categories of work and a whole new set of problems that tooling up for defense produced.

For one thing, the sweeping changeover in midyear to negotiated cost-plus-fixed-fee contracts for the great bulk of defense work profoundly modified the whole business of construction; by now some 80 to 85 percent of naval public works and at least half of the army work is being awarded on this basis.

#### Problems of fixed-fee contracts

To the government, negotiated fee contracts offer major advantages. They get going fast, both by eliminating the time required for advertisement of bids and by making it possible to award the contract before plans are far enough along for potential contractors to prepare intelligent lump sum bids. More importantly, they keep the contract flexible. A cantonment job may be first intended to house 5,000 men; six months later it is a 20,000-man project. Under lump sum contracts this would present an impossible situation, while on a negotiated contract it is only necessary to change the plans and perhaps adjust the fee to cover increased overhead. Moreover, with capacity production the watchword, in construction as in industry generally, it is important that the government be able to allocate its work among the contractors of the country in the most efficient manner rather than solely according to who figures his bid with the sharpest pencil.

From the contractor's angle the whole technic of getting business from the government is changed. No longer is it a technical problem of estimating the cost of a job skillfully. Instead, it is a sales job—very similar to that involved in getting a private contract.

First step of each of the government agencies negotiating contracts (principally the Navy's Bureau of Yards and Docks, Army's Quartermaster Corps and Corps of Engineers, and the Federal Works Agency) has been to compile classified lists of available firms. Except for Quartermaster Corps, they relied heavily on their long familiarity with the industry — thus inevitably giving something of an inside track to firms accustomed to government work. But all arranged to give unfamiliar firms consideration. The Quartermaster Corps, which is undergoing a much greater proportionate expansion of its work than the other agencies, established a board of civilians to handle this problem. The board solicited applications from contractors, interviewed personally representatives of most of the firms, and from the resulting list made preliminary selections of the contractors to handle specific jobs. In theory, the board decides that a particular firm should be considered for a particular project; in practice successful contractors have come to Washington with their eyes on a specific job.

In practice too, the fee to be paid is set by the government rather than negotiated. Under the law, the fee on Army contracts may not exceed 7 percent, on Navy contracts 6 percent. On large jobs some fees have run as low as 2 or 3 percent. Out of this fee the contractor must obtain interest on working capital, company overhead, executive salaries, and profit. Other costs are paid by the government. The fee does not vary with the cost of the job, except that if the whole scale of the work is changed the fee is adjusted. There is at present no incentive to hold down costs except that it improves the firm's chances of getting another contract. Studies are underway of the possibility of some sort of bonus for economy.

Once he has obtained a defense job, the contractor faces a lot of special problems not encountered in ordinary lump-sum work. Foremost is the fact that he is essentially a hired hand rather than an independent business man. No longer is he merely required to meet the specifications; now he must obtain approval for his methods of work, the men he hires, the rates he pays, the equipment he uses. He can hardly change a truck tire on his own initiative. Contractors are an independent lot, and most of them find this irksome—how irksome of course depends largely on the personality of the government representative who happens to be handling the job. Also, nearly all fee jobs are being designed as they are built (that's why they are fee jobs). This greatly increases the contractor's difficulties and the strain on his temper.

Finally, detailed cost records must obviously be kept on fee jobs, and construction has never been an accountant's field.

The policy of centralized buying which has been adopted by the War Department for most materials has also created new problems. The Defense Commission has pushed this policy, feeling that it enables the supplier to schedule his work more intelligently, prevents pyramiding of orders, and holds prices in line. Critics say that by concentrating attention on the big suppliers the plan artificially restricts the supply. Be that as it may, the policy unquestionably increases the difficulties of the contractor, since it practically eliminates his control over delivery of materials to the job.

On the financial side, the fee contract has taken the gamble out of

construction. No contractor who keeps any kind of control of his overhead can lose his shirt on a defense job. On the other hand, he can't get rich, and he can sometimes end up with a net loss through no fault of his own. On the cantonment jobs, particularly, the fees are likely to run to a much lower percentage than originally intended. Fees are set as a percentage of the estimated cost, and it is now admitted that the original estimates on the cantonments were far too low. Under present law, the fee can only be changed if the actual scope of the work is altered.

Then there is always the possibility of costly future lawsuits over the allocation of costs. Some contractors, too, are worried lest high accident rates on these rush winter jobs, using many unskilled men, adversely effect their insurance charges on future work.

#### No boom for small contractors

The smaller contractor, so far, is not benefiting much by defense work. Most contracts have gone to two or three hundred larger firms, while the rest actually find their opportunities curtailed by the trend towards decreased non-defense public works. In areas where there is a lot of military work, the smaller contractors are getting a better chance at civil jobs because some of their competitors are loaded up with defense contracts. And house-builders are already feeling the stimulating effect of rising employment. But in many places, smaller contractors are disbanding their organizations and taking jobs as superintendents and foremen for the big fellows.

#### Priorities and prices

With the exception of lumber, supply of construction materials has occasioned no real problems during 1940, but there are indications that this happy state may not continue through 1941. Priorities for defense work may be imposed upon some materials; structural steel shapes are considered quite likely to be affected. Hydro projects using large turbines and generators may find themselves in difficulty before the end of the year as a result of the naval demand for turbines. Possibility of priorities on transportation cannot be ruled out, though so far they appear improbable.

The lumber situation itself is not a question of shortage so much as of price. Government and the industry agree that ample supplies are available. The industry claims that most, and the defense commission implicitly admits that some, of the blame for skyrocketing prices must go to clumsy buying by the Quartermaster Corps—resulting in local shortages and pyramiding of orders. Whatever the cause, the clear prospect for the coming year is drastic governmental control unless the price comes down.

#### Labor supply problems

Defense officials, government agencies, and unions are unanimous in declaring that in spite of record levels of construction no over-all labor shortage has developed, though local and temporary difficulties are admitted. Unquestionably, in many areas where big defense jobs have been dropped into small communities the entire local labor supply has been absorbed, and extensive migration of labor from other regions has been necessary. It appears, however, that in nearly all cases the employment services and the unions have been able, one way or another, to furnish men. Some private construction has been handicapped by the tendency, in the presence of widespread demand for men, for all wages to rise to the union rates prevailing on government jobs. This has been intensified by the way in which wages on cost-plus jobs are likely to rise in an effort to attract men.

Both private and defense work has been affected by a general degradation of skill standards, more or less inevitable as full employment is approached. Hundreds of men are drawing carpenters' wages on cantonments who have never done carpenter work before. And apart from such extreme cases, every employer is hiring men now whom he wouldn't have hired a year ago when he was free to pick and choose.

Migration of construction labor into other industries has not been significant so far, but in the coming year it may have important effects in some of the trades. Moves are already underway to recruit ironworkers into the shipyards, and the continually increasing shipbuilding program could absorb a lot of men.

#### Unions for all

The past year saw a great increase in union organization of construction. Unionization is all but universal on federal work and has become the rule rather than the exception on all but small jobs in small communities. The defense program has had a great deal to do with this, simply by increasing the proportion of government work. Prevalence, too, of big jobs combining many types of work brings less unionized fields such as roadwork into close contact with highly organized types like building.

The increased importance of union relations resulted during 1940 in expanded participation by local chapters of the Associated General Contractors. A great many of these bodies now sign union contracts binding on their members. So far the national organization has not taken this step, but it regularly acts as agent for particular chapters in dealings with the Building Trades Department of the American Federation of Labor.

Strikes of more than a few hours' duration have been almost nonexistent on national defense projects, though there have been frequent threats that came almost to the point of a stoppage. Secretary of War Stimson said recently, for instance, that only about one percent of the delays on the cantonment program have been chargeable to labor troubles.

This record is attributed in part, of course, to the fact that no one is worrying very much about economy on the rush projects now underway. But equally significant has been a definite policy of moderation on the part of leaders of the building trades unions. As early as last July, President Possehl of the operating engineers announced that his locals would call no strikes until all means of mediation had failed. And as the year ended, President Coyne of the Building Trades Department announced a similar policy.

Strictly speaking, such a departmental policy is not binding on the component unions, but Coyne, of course, had obtained the assent of officers of all his internationals before announcing the policy. Moreover, observers point out that on cost-plus jobs a union demanding higher wages must in practice obtain the consent of the government agency which has made the contract, and this consent would hardly be forthcoming if Coyne's department withheld its support. There is some discussion of incorporating the pledge in union agreements.

Non-defense construction has not

enjoyed the same freedom from stoppages, but even here there have been few strikes of any severity.

### Jurisdictional dispute control

Perhaps even more surprising has been the almost complete elimination of the jurisdictional strike. The new system for elimination of such stoppages has worked out better than the most optimistic had hoped. Initiated by the Building Trades Department late in 1939, partly at the suggestion of the A.G.C., the plan provides that, when a dispute arises over jurisdiction, work shall continue while the question is appealed to President Coyne, the trade already in possession meanwhile doing the disputed work. Coyne thereupon makes a ruling, either finding that the point in dispute has already been settled by a convention decision or himself making a temporary decision. Such a temporary decision is binding as regards the particular job where the dispute arose but sets no precedent for the future; this point is vital, since it removes the incentive to make a last-ditch fight of every jurisdictional question.

For a permanent decision, the jurisdictional problem is referred to an impartial arbiter, who is supposed to hold hearings and make rulings.

This procedure has been written into a number of local union agreements between building trades councils and A.G.C. chapters. Several of these have incorporated the additional feature of a fact-finding board to investigate disputes and make a report to guide Coyne's ruling. There were hardly more than a dozen cases during 1940 in which jurisdictional disputes resulted in serious work stoppages.

Meanwhile, Coyne has issued about 750 rulings, most of them in cases which in previous years would have resulted in strikes. Final test of the plan will come when the arbiter issues some final decisions. Due to various delays none were arrived at last year. Some eighteen or nineteen basic types of disputes are now awaiting decision, and hearings on them have been set for April.

### How the CIO is doing

CIO organization is still a minor factor in the construction industry, but the CIO's Construction Workers Organizing Committee experienced considerable proportionate growth during 1940, entering the year with about 80 locals and ending with some 230. Membership has not increased in the same ratio, since the new locals are smaller; membership figures are not announced, but CWOC probably has some 3,000 to 5,000 men.

Backbone of CWOC strength remains the largely unorganized small-house field. An important organizational technic here has been to use the buying power of CIO industrial workers; a slogan of "CIO homes for CIO workers" has been pushed, and in several cities CIO unions have helped to market houses for speculative builders who agreed to sign up with CWOC. Organizational methods in general have remained rather nonmilitant; the union has made a definite effort to appeal to employers, pointing out the convenience of an industrial union set-up and the possibility of getting the advantages of a union contract without paying high AFL craft scales.

### CWOC expansion

There was considerable expansion during 1940 of CWOC activity into gravel pits, brickyards, and mill-working plants. The only venture into heavy construction has been on highway work; some success has been had in Pennsylvania. In some cases where AFL teamsters refused to service CIO jobs, CWOC has organized locals of truck-drivers. There appear to have been surprisingly few cases of serious trouble resulting from CIO-AFL conflict. Some cases of cross-picketing have arisen, and there have been one or two minor riots—principally in the St. Louis area, which is a center of CWOC strength. Other strong points are New York City, Washington, Cincinnati, Detroit and the West Coast.

The drive active on the West Coast in 1938 and '39 to organize workers on heavy dam and tunnel projects into CIO's Mine, Mill, and Smelter Workers seemed in 1940 to have petered out.

In general, then, the industry enters 1941 with good relations obtaining between employers and employees. Contractors in the main have reconciled themselves to the inevitability of union organization; union leaders are following a fairly moderate line. Most of the major issues now pending involve measures to simplify the practice of peaceful collective bargaining.

Where the fireworks are likely to come is in the relation of government to the unions. The whole question of the place of labor in defense is going to be a hot one all through 1941, though the relatively stable construction industry will mostly be affected by the backlash of issues arising in other sectors of the defense effort.

### Restrictive labor laws avoided

The administration so far has tried to stave off restrictional labor legislation, relying instead upon mediation and extra-legal pressure in particular situations as they arise. The President, however, does not rule out more drastic measures in the future. Insofar as a long-range administration policy can be discerned it seems to involve taking whatever steps are needed to prevent interference with production — meanwhile sweetening the pill by permitting the unions to strengthen their formal power in industry and by drawing labor leaders into the administration of the defense program.

Likely during the coming year is legislation extending to all industry the principle of the Railway Labor Act—a statutory waiting period before strikes may be called, coupled with official investigation of the issues.

### Union fee criticized

The touchiest government-labor question applying directly to construction is union initiation fees. The AFL unions have been severely criticized in the press and in Congress for collecting the regular initiation fee—or even a higher one—from men who are only temporarily in construction. A partial response to this criticism was made early in January when Coyne urged his international unions to set maximum fees which locals may charge; this would not substantially reduce fees, but it would prevent locals controlling big defense jobs from suddenly jacking up their membership charge.

An effort will unquestionably be made in Congress to put statutory limits on fees, but if the above analysis of administration policy is correct, such attempts will not get far. However much they shock the public, high fees don't slow up the work, and union officials will argue off the record that to permit non-union men to work on AFL jobs would be an invitation to CIO—and real trouble.

# Developments in Building

**Signs of the times are windowless wall factories, prefabricated houses, uses of new building elements, and a searching for what constitutes bomb-resistant construction.**

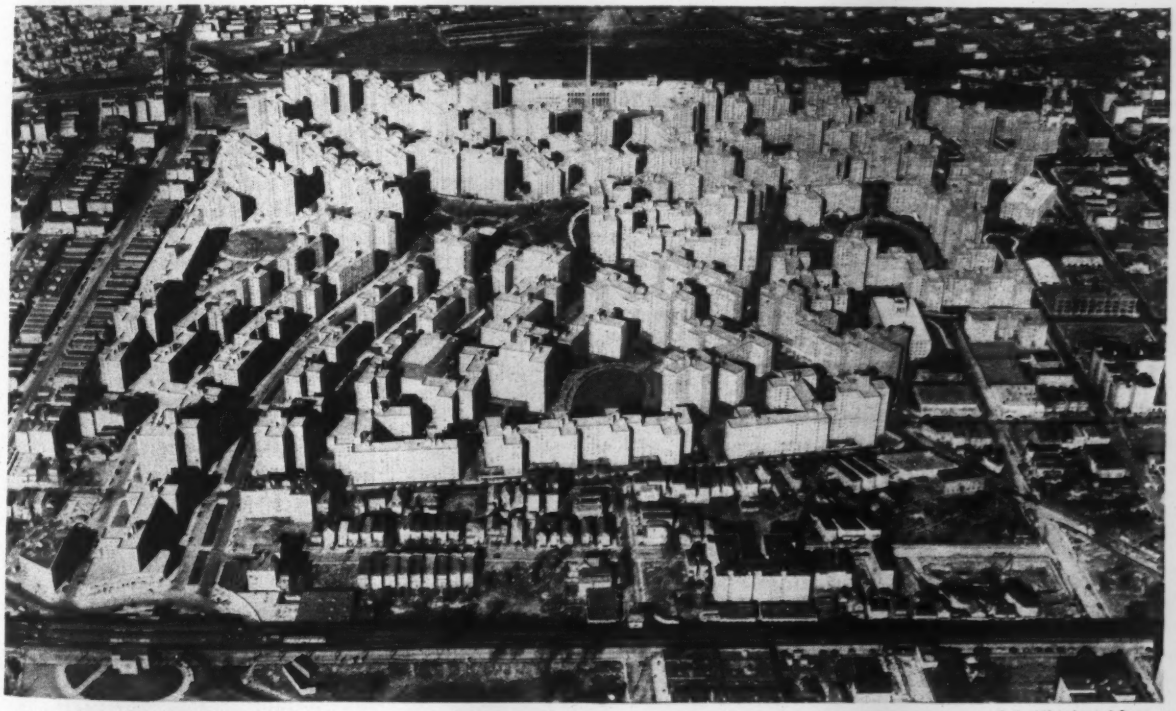
***Waldo G. Bowman***

IF TECHNICAL ADVANCE in a given field were a direct product of activity in that field 1940 would indeed have been a banner year in building, for the 2.2 billion dollars of contracts let has been exceeded only once (1929), and equalled in only one other year (1928). But even though the relationship of technical progress and building activity is not as favorable to the former as it might be, there were significant developments recorded in 1940. There would have been more but for the speed and secrecy that characterized the defense program and thus tended to obscure advances in design and construction technique. Since these developments will all become known in due time the only result of the secrecy is to withhold them from wide use now when they might aid our national defense.

Despite their shortcomings, however, national defense buildings, of which the majority are of industrial type, completely dominated the year, and therefore command first attention. Several airplane plants of the windowless type were built and heralded as "blackout" factories, although in the decision to build them the advantages of controlled light and air probably outweighed any reduced war risk feature. Since aeronautics plant floorspace will have been increased from 12 to 45 million sq. ft. when the current expansion is complete, the fact that two million square feet, more or less, went into windowless plants can hardly be styled a trend, although it is significant.

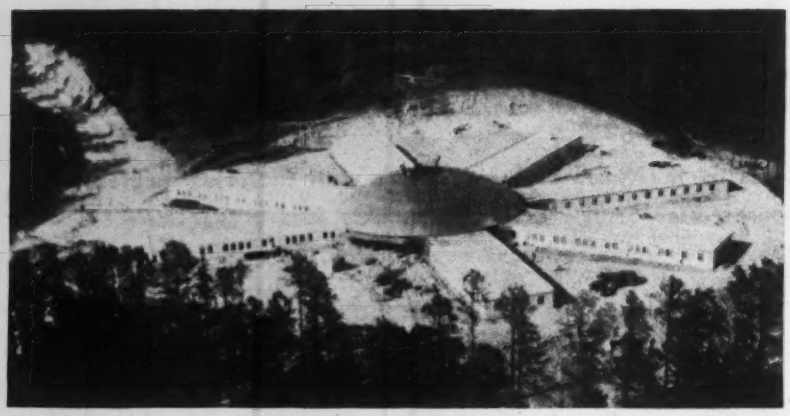
There is a trend, however, in the greater use of underfloor utility space in airplane plants and factory buildings generally. And the trend might almost be said to encompass the use of basements, for a number of the defense plants have subterranean passageways for employee traffic movements and basement rooms for lockers and cafeterias.

Army and Navy airbase programs caused long-span trusses to be turned out in great numbers; but neither the arch nor parallel chord types used go beyond conventional practice. Two or three hangars of thin concrete shell construction have been tried, but largely as an experiment, it would



*Fairchild Aerial Surveys*

***Ace of housing developments is Parkchester, built by the Metropolitan Life Insurance Co. in New York City. A self-contained city for 40,000 people, it is suggestive of one type of building job that may multiply in the future.***



***Welded steel box units make up the entire enclosure and frame of this unique hotel building in Georgia. The dome is 100 ft. in diameter.***

seem. The most notable building of this type built during the year was a commercial skating rink in Washington, D. C.; its arch spans are 132 ft., and the building is 325 ft. long.

#### New trends in housing

The defense program may also give the prefabricated house the lift in popularity that it has needed. As a trial, a government-owned 650-unit defense worker project, Indian Head, Md., has been proposed to be made up of about a dozen different types of commercial prefabricated houses.

The USHA finished more projects in 1940 than in any other year of its life. Substantial reinforced-concrete frame or masonry bearing wall types, they followed conventional practice. Costs—$2,856 per dwelling unit—are down about to the minimum possible with this type of construction. Taking a cue from the large-scale community projects of USHA, the Metropolitan Life Insurance Co. completed its Parkchester development in the Bronx, New York City. At least five times as big as any previous public or private housing development, it is a self-contained city of nearly 40,000 population. Steel frame buildings were used, some as high as 13 stories. The same company is now starting another project in San Francisco. With large investors, such as insurance companies, going in for equities instead of mortgages there is a real chance for improvements in building to come faster from now on.

Earthquake-resistant design for small-town buildings as distinct from city skyscrapers was emphasized by the quake that caused extensive damage to towns in California's Imperial Valley. Again it was enclosures weak at the corners, roofs not anchored to walls, parapets without bracing, that caused the principal losses. Frame buildings, even though not designed for horizontal forces, showed remarkable resistance, and those designed for earthquakes were virtually undamaged. A notable large building designed against earthquakes was the Hoover Library at Palo Alto, Calif. Its concrete wall enclosure rather than its steel frame was proportioned to resist the earthquake forces, on the basis that if the frame is made the resisting element the walls must crack to bring the frame into play, and this means a costly repair job. The designers of the Hoover Library hope to avoid such maintenance charges.

#### Better brick walls

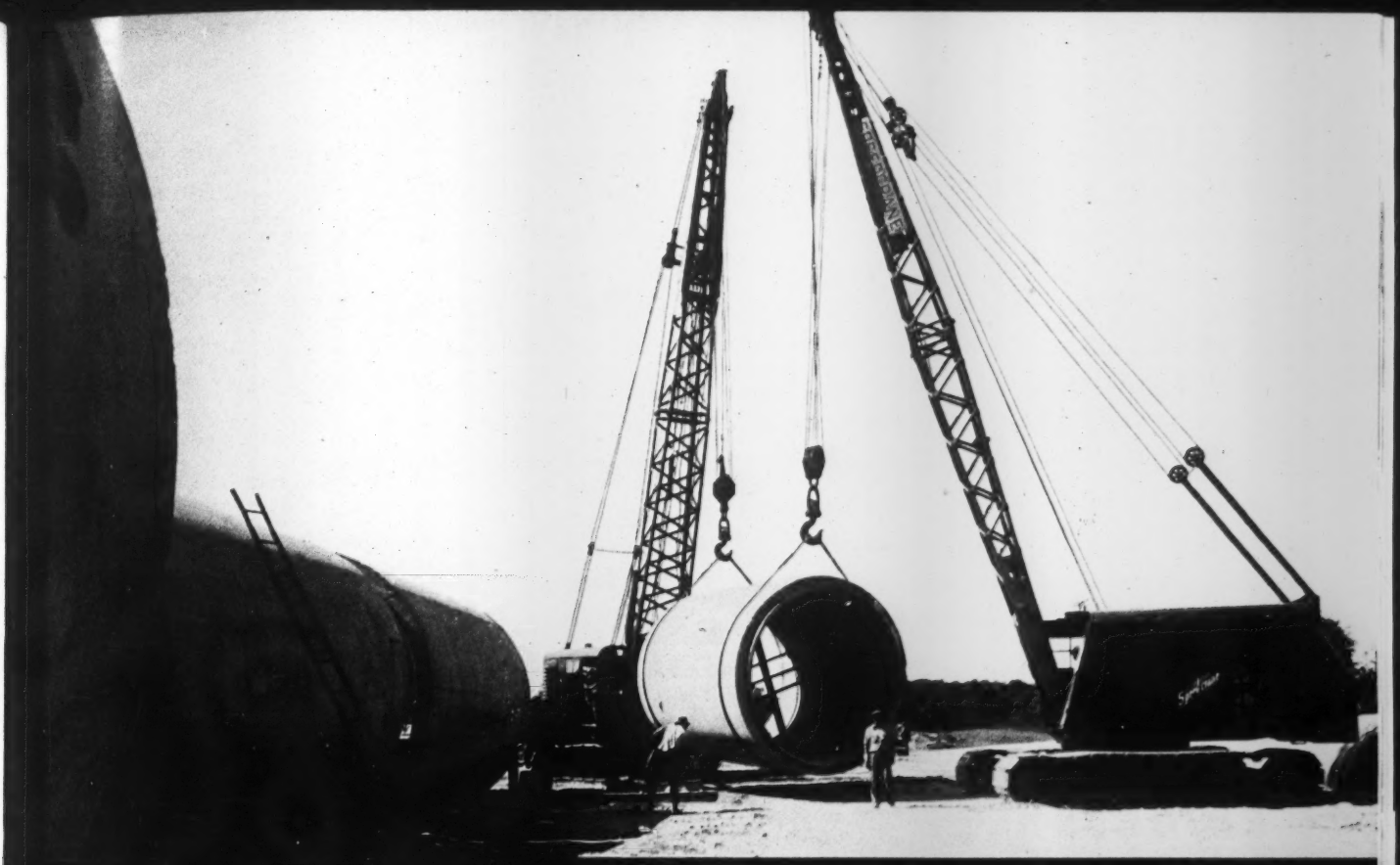
Innovations in design were not as numerous as in some years. One of the most interesting was the brick "cavity" wall, common in Europe, but used in this country for the first time in an apartment house in Montclair, N. J. Consisting of two 4-in. withes separated by an air space, the wall has a definite insulating value and, by virtue of flashing of asphalted felt and copper, is leakproof. Metal ties placed every sixth course impart unity and rigidity to the construction.

For structures that depart radically from precedent a new factory building for R. G. Le Tourneau, at Peoria, Ill., takes first place. Its walls contain no columns, its roof no girders or trusses, yet it has bays 40 ft. square. The answer is the use of welded cellular steel box units for both walls and roof. Interior pipe columns are used, and are connected across the top by steel plates standing on edge and welded to the roof units; these plates or load-distributing diaphragms are the nearest approach to girders in the building. A second installation of this welded frameless steel construction was in a hotel at Toccoa, Ga., where the cellular units were also used for a 100-ft. dia. dome as shown in an accompanying illustration. Another welded building of note was the new Air Lines Terminal in New York City; its five stories of framing are completely welded and include trusses weighing as much as 30 tons each.

Utilization of new or improved construction elements in buildings continues to be widely noted. Enclosure of the naval hospital at Bethesda, Md., with exposed-aggregate concrete slabs is a step forward for this new building medium. Timber trusses fabricated with shear dowel connectors increased in popularity, and proved particularly useful on some of the rush factory jobs for national defense. Composition boards in sizes as large as the whole side of a room were used in low-cost houses, exhibiting advantages in economy and rapid construction. Precast concrete floor joists were also used effectively in several large housing projects.

#### Bomb-proof construction

The necessity of accommodating air conditioning ducts in commercial buildings without creating an unsightly appearance or taking up unnecessary space has posed a new problem for building designers, which has been met in some cases by new types of framing arrangements. And looking into the coming year, it seems certain that requirements for bomb resistance will be another new problem for the building engineer to meet. Little enough information on the forces involved, on the experiences of Europe, or on the possibilities of our needing such protection, is available, but some owners have already placed bomb resistance on a par with wind resistance among the things that they want. Engineers will thus have to develop designs that are rational both economically and structurally. Add to these special problems the many that are inherent in a continuation of the high pressure job of creating new defense factories and housing accommodations and 1941 looms as a year of unusual activity and accomplishment in building.



# MAJOR PROJECTS OF 1940

*Progress during the year on major projects from coast to coast is briefly recorded in the following pages. Roughly the jobs listed include normal operations costing more than one million dollars. Construction of airplane factories, armament plants and shipyard facilities related to the national defense program is treated elsewhere in this issue. ENR is indebted to the many engineers and officials who provided the data upon which the individual items are based.*

**WATER SUPPLY • FLOOD CONTROL • WATERWAYS • BRIDGES**
**SEWAGE DISPOSAL • LAND RECLAMATION • BUILDINGS •**
**POWER • IRRIGATION • TUNNELS • HIGHWAYS • AIRPORTS**

Airvue Associate Photo

*New four-lane Susquehanna River crossing at Havre de Grace, Md., is 7,620 ft. long, and includes 24 Wichert type girders and 12 Wichert type trusses. Channel spans are 456 ft.*

# BRIDGES

*BATON ROUGE*—Formally opened to traffic Aug. 10, the new bridge across the Mississippi at Baton Rouge provides for two 22-ft. roadways supported on brackets outside the trusses and for two Louisiana & Arkansas R.R. tracks between the trusses. The $9,500,000 cantilever structure is 3,326 ft. long with the central span 650 ft., the two adjoining spans 858 ft., and the two shore anchor spans 490 ft. The project required three years for completion.

*LAKE WASHINGTON*—Including a 6,561-ft. floating portion of hollow concrete box pontoons that accommodate a 45-ft. roadway to permit two lanes of traffic in each direction, the $9,000,000 Lake Washington toll crossing at Seattle was opened to traffic the first week in July. Most unusual feature of the bridge is a 378-ft. sliding or telescoping section by which it is possible to provide a 202-ft. passageway for boats. The bridge, saving 14 miles of driving between Seattle and eastern points, is 7,721 ft. in total length.

*PIT RIVER*—At the end of the year, structural steel erection had begun on the 3,588-ft. double-deck Pit River Bridge, which will carry a relocated railroad and a highway about 500 ft. above streambed in the Pit River arm of the Shasta reservoir (Central Valley Project). The bridge substructure, comprising 10 concrete piers and 4 abutments (separate abutments for rail and highway levels), was completed except for the two largest piers each more than 350 ft. high. These two had been built up to about two-thirds their final height by the end of the year.

*ST. GEORGES, DEL.*—At the end of the year substructure work was well advanced on the 540-ft. steel tied arch which will span the Chesapeake & Delaware Canal near St. Georges, Del., on the site of the old vertical lift span that was destroyed when a freighter rammed it in January, 1939. A connecting link in the du Pont Highway, the arch, giving 135 ft. shipping clearance, is flanked on each end by 1,800 ft. of beam and girder approaches. Completion date is set for October, 1941, and the total cost is estimated at $2,400,000.

*NIAGARA FALLS*—With the placing of abutment concrete completed Dec. 23, preliminary work had begun as the year ended for erecting the 950-ft. hingeless steel arch of the Rainbow Bridge being built across the Niagara River at Niagara Falls, N. Y. Scheduled for completion in September at a cost of $3,760,000, the highway structure will provide two 22-ft. roadways separated by a 4-ft. center island plus a 10-ft. sidewalk on the upstream side. The structure, 1,450 ft. overall, will be the largest fixed-end arch bridge in the world. It is to replace the "Honeymoon" span destroyed by ice in January, 1938.

*POTOMAC RIVER*—The unusual substructure of the Ludlow Ferry Bridge, 50 miles below Washington, was completed early in the year. The superstructure, 24 ft. wide—plus sidewalks—and 10,050 ft. long, was erected by the balanced cantilever method for the 800-ft. main channel span. Floated-in falsework trusses were used for most of the other long spans. The structure was opened to traffic in December as a toll project of the Maryland State Roads Commission.

*LORAIN, OHIO*—Two bridges were completed over the Black River at Lorain during the year. A 1,700-ft. continuous truss, providing for four lanes of traffic on an undivided 42-ft. roadway, was opened July 4. The country's longest double-leaf highway bascule, 333 ft. between trunnion pins, was finished late in the fall.

*NATCHEZ, MISS.*—Providing the only Mississippi River bridge crossing in the 150-mile stretch between Vicksburg and Baton Rouge, the Natchez, Miss.-Vidalia, La., bridge was opened to highway traffic Sept. 26. The bridge proper is 4,205 ft. long and includes two 875-ft. spans—the longest over the Mississippi. The $3,450,000 cantilever toll structure was financed by a PWA grant and an RFC loan. Its roadway is 24 ft. wide to provide for one lane of traffic in each direction.

Fonville Winans Photo

*Two 22-ft. roadways outside the trusses and two railroad tracks between the trusses are provided by the new $9,500,000 Mississippi River Bridge at Baton Rouge, La.*

*U. S. Route 1 traffic uses top deck of this new bridge across the Piscataqua River at Portsmouth, N. H.; the lower deck carries Boston & Maine R. R.*

*Unusual feature of $9,000,000 Lake Washington pontoon bridge opened in July is a 378-ft. telescoping section to permit passage of boats.*

*Below—Tacoma Narrows suspension bridge before and after collapse of deck of 2,800-ft. main span Nov. 7 in a 42-mph. wind. The bridge had been in service four months.*

*GREENVILLE, MISS.*—Built at a cost of $4,500,000 by the city of Greenville, Miss., the new toll highway cantilever bridge across the Mississippi River at that point was dedicated Sept. 17 and opened to traffic Oct. 5. The crossing has an 840-ft. main span and two 640-ft. anchor spans. The work was financed by a $2,000,000 PWA grant and a $2,200,000 RFC loan.

*PORTSMOUTH-KITTERY* — Connecting New Hampshire and Maine across the Piscataqua River, this new bridge permits highway traffic on U.S. Route 1 to bypass the Portsmouth business section and in addition carries the Boston & Maine R.R. on its lower deck. About 5 miles of new approach roads form a part of the project, which was sponsored by the Maine-New Hampshire Interstate Bridge Commission and financed by PWA and RFC. The highway deck, 2,800 ft. long, carries a 30-ft. roadway and two sidewalks. The railroad deck, for a single track, is 1,606 ft. long. The channel crossing is a 224-ft. lift span flanked by two 225-ft. trusses and a series of plate girder spans at either end. Total cost of the project was about $2,500,000.

*RARITAN RIVER*—First and only long high-level plate girder bridge in the country, the New Jersey highway department's Raritan River span at Perth Amboy was opened to traffic during the year. Named the Thomas A. Edison Bridge, it contains eight 200-ft. spans and one 250-ft. span as well as 20 shorter spans, which brings the total length to 4,386 ft. The channel span clearance is 135 ft. Most notable feature is the 250-ft. span girder which is 21 ft. deep over the supports, a maximum for this country. The bridge has five traffic lanes and two walkways on its 55-ft.-wide deck.

*TACOMA NARROWS*—One of the greatest bridge failures on record occurred Nov. 7, 1940, when the deck of the 2,800-ft. main span of the Tacoma Narrows suspension bridge, after only four months' service, collapsed as the result of violent vertical wave motion arising, it is believed, from aerodynamic instability of the floor system. Two boards of engineers, one representing the Washington Toll Bridge Authority and another representing federal interests, had under consideration at the end of the year the question of whether the cables and towers could be used in reconstructing the bridge.

*HOUSATONIC RIVER*—Two unusual features characterize the bridge which carries Connecticut's Merritt Parkway over the Housatonic River—one-leg bents and 1,824 ft. of open steel grid flooring. Opened to traffic in the early fall, this plate girder structure, three girders wide, carries a four-lane divided roadway. The 224-ft. channel span is a cantilever, balanced by 160-ft. anchor arms. Girder depth is uniform throughout, despite the use of some spans only 128 ft. long. Reason for the one-leg bents was that the single cylinder piers which support them permitted a shorter span than would a conventional rectangular pier in giving the required horizontal shipping clearance in a channel that is at a 58-deg. angle with the bridge center line.

*HAVRE DE GRACE, MD.*—Contrasting sharply with the well known, old and ugly double deck bridge that it replaces, the new crossing of the Susquehanna River at Havre de Grace, opened in August, offers greatly improved travel for traffic between Philadelphia and Baltimore. In its 7,620-ft. length are 54 spans, 24 of which are Wichert type girders and 12 of which are Wichert type trusses. Included in the latter are 2 three-span continuous units that cross shipping channels on either side of an island in the river. The channel spans, 456 ft. long, are of through-type while the remainder of the bridge is of deck construction. A four-lane roadway 46 ft. wide is provided. Total cost, financed by a bond issue and a PWA grant, was $4,727,000.

*JAMESTOWN, R. I.*—Travelers along the New England coast were saved either a ferry ride or a 50-mile detour when the new bridge across the west channel of Narragansett Bay from the mainland to Conanicut Island, where the town of James-

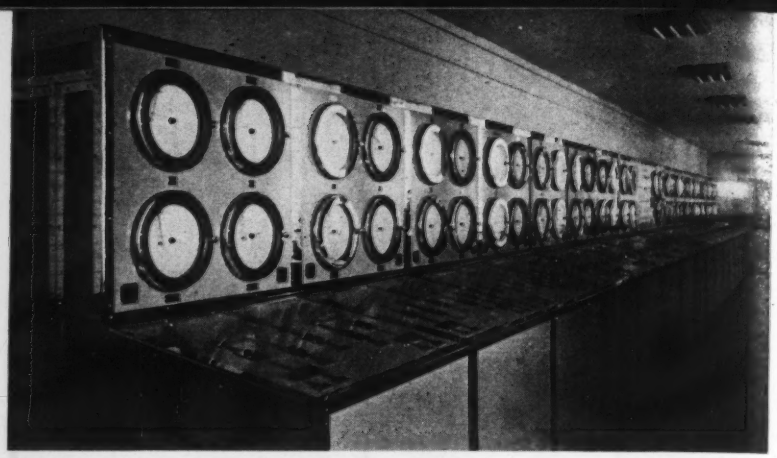
town is located, was opened last summer. Nearly 7,000 ft. long, the bridge is the longest in New England. Most of the length is made up of 60 plate girder and concrete trestle spans, but the deepwater portion contains six 270-ft. deck truss spans and a through cantilever bridge with a 640-ft. main span giving a 135-ft. shipping clearance. A 22-ft. roadway and a 3-ft. sidewalk are provided. Owned by the Jamestown Bridge Commission and financed with the aid of a PWA grant, the bridge cost about $3,000,000.

*ROCK ISLAND*—Including five steel tied-arch spans varying in length from 395 to 539 ft.—the first spans of this type ever built across the Mississippi River—the Rock Island, Ill., Centennial Bridge was dedicated and placed in service July 12. The deck accommodates two 22-ft. roadways separated by a 2½-ft. steel center island, while a 5-ft. sidewalk is bracketed out at either side. Built at a total cost of $2,500,000 by the city of Rock Island, the bridge will be paid for by a 10c. toll.

*MAIN AVE., CLEVELAND*—Although this long high-level viaduct over Cleveland's Cuyahoga Valley was completed in 1939, its eastern approach ramp connecting with Lakefront Road belongs to 1940. The 2,530-ft. ramp structure carrying two 24-ft. roadways is particularly notable, for it contains the country's longest plate girder span, 271 ft. There is also included about 1,200 ft. of steel rigid frame construction in 2 and 3-span continuous units. The ramp was opened to traffic in the fall.

*PEORIA, ILL.*—Following an award July 13 of a $625,000 contract, construction of the substructure of a toll-free bridge across the Illinois River at Peoria, Ill., started in September. As the year ended the substructure was one-third completed and this work is expected to be finished by the end of 1941. The superstructure work is to be awarded in the near future with the bridge scheduled for opening at the end of 1943. The bridge proper will be 4,695 ft. in length and will provide a 26-ft. roadway with two 2½-ft. safety walks. The steel cantilever superstructure calls for a 536-ft. main span and two 469-ft. end spans. West of the main cantilever section will be two continuous 3-span deck truss series and a 2-span continuous deck girder. East of the cantilever structure will be one continuous 3-span deck truss, two continuous 3-span deck girders, two continuous 3-span I-beams, and one simple I-beam span. The Illinois Department of Public Works and Buildings is doing the work.

*HARTFORD, CONN.*—Begun in September, a new Connecticut River crossing at Hartford is destined to be one of the important bridges of the current year, because it will contain a 300-ft. plate girder span, longest in this country. This long span is flanked by 271-ft. girder spans, and there are long viaduct approaches on either end, the one in Hartford having a southwest and northwest arm. Total length of bridge is about 3,900 ft. It will greatly relieve traffic to and from East Hartford where large airplane engine plants are located. Completion date is July 1, 1942.



*Central control board installed at the Providence, R. I., filter plant. Recorders for loss-of-head and rate-of-flow are mounted on vertical panels, and the bench board section contains mimic piping diagram of filters and push-button stations.*

# WATER SUPPLY

*ATLANTA*—A $1,250,000 pay-as-you-go waterworks improvement program started in 1938 and financed with 10 p rcent of revenue set aside each year for this purpose, shows consistent progress. A 33-mgd. filter plant is 40 percent complete, distribution system improvements will be finished in 1941, and work has been completed on two 32-mgd. settling basins and large pumping units.

*BALTIMORE*—Practically all of the work in connection with the Gunpowder Falls-Montebello Tunnel—a 34,600-ft. bore having a finished inside diameter of 12 ft.—was completed, water being admitted for the first time on Dec. 11. Pressure and leakage tests in a trial run of the unwatering equipment were satisfactorily completed to enable the tunnel to go into service on Dec. 23. There remain to be completed the installation of a control vault and the lining of a short section of the old Loch Raven Tunnel, work which could not be done until the new tunnel was placed in service.

*BOSTON*—The spillway of Windsor Dam for Quabbin Reservoir is completed, and the superstructure for housing valves and other equipment in the outlet works below the dam is under construction. Storage in the completed reservoir has now reached a total of 70 billion gallons and the water depth at the main dam is 88 ft. Total capacity is 415 billion gallons with final water depth at 150 ft. The new 18-mile pressure aqueduct from the Wachusett Aqueduct to the western border of the water district has been completed, and a shaft is now under construction from which a distribution tunnel to Chestnut Hill will be extended. Construction is also under way on a superstructure to house valves and other equipment controlling the flow in the pressure aqueduct and its connection to the Weston Aqueduct and Sudbury Reservoir.

*PHILADELPHIA*—The Philadelphia Authority, created in September, 1938, to finance $20,000,000 worth of waterworks improvements for that city, was abandoned by the new city administration that came into office in January, 1940. The administration decided to undertake the work—both financing and construction—directly. The project, authorizing a bond issue of $18,000,000, was placed before the voters and approved on April 23, 1940. Consulting engineers were engaged to check the plans of the department of public works, and for investigation and surveys. The report, with recommendations, has been accepted. The department is organizing its technical and engineering staff, and plans are now in the course of preparation. First major units are expected to be advertised for bids about March 1 of this year.

*PROVIDENCE, R. I.*—With the completion of four new filters, a pneumatic materials handling system, electrification of all valves and a centralized control system—all at a cost of $600,000—a $1,400,000 improvement program was brought to a close. Completion of the concrete lining of the coagulation basins was reported last year.

*DELAWARE PROJECT*—On the 85-mile Delaware Aqueduct tunnel excavation is 95 percent complete; finished excavation for shafts and tunnels exceeds 5,100,000 cu.yd. Some 21 miles of the tunnel is already lined with concrete. At the Merriman Dam, the 2,825-ft.-long concrete cutoff wall—including the 920-ft. main section constructed with pneumatic caissons—is nearing completion, and 600,000 cu.yd. of excavation for the gate house and other structures has been finished. The placing of the rolled embankment will begin in the spring. At the Neversink Dam the first highway contract is under way and a contract for the cofferdam, diversion tunnel and exploratory caissons has been advertised. To date $109,000,000 of work has been done, $60,000,000 of which was undertaken during 1940.

*CENTRALIA, ILL.*—A new $1,000,000 water supply will be undertaken as soon as a decision can be made between two favored projects. Each plan involves an impounding reservoir and a low-lift pumping station and enlargement of a pipeline to an existing filter plant. An existing pumping station is to be remodeled.

*OKLAHOMA CITY*—Bids for $6,900,000 worth of bonds were opened Jan. 7, 1941, for construction of waterworks improvements consisting of a new reservoir, pumping station, filtration plant and distribution betterments.

*GRAND RAPIDS*—The $4,100,000 Lake Michigan water supply facilities, completed in May, involved a 6,000-ft. 54-in. intake pipe, 30.6 miles of 46-in. concrete pipe, two high-lift pumping stations, two covered reservoirs having a combined capacity of 24 mg., and feeder mains. A special feature of the project is a circular low-lift station at the lake shore in a 50-ft. excavation.

*CHICAGO*—Work on the 320-mgd. South District filtration plant has progressed rapidly with $12,000,000 of contracts let during the year. The park and beach fill, the 16-ft. connecting tunnels and substructure of the entire plant were substantially complete. Items now being delivered and erected are four 100-mgd. and four 50-mgd. electrically driven low-lift pumps, sluice gates, piping, valves and meters. In 1941 $6,500,000 is scheduled to be expended. The 12-ft. Desplaines St. rock tunnel from the Chicago Avenue tunnel to the Cermak pumping station was completed and put into service. The mining of the 10-ft. rock tunnel along Stewart Avenue from 73rd and State St. to the Roseland pumping station was finished and the lining one-third completed.

*HOUSTON*—A recent report on groundwater conditions by the State Board of Water Engineers in cooperation with the U. S. Geological Survey states that the present 81-mgd. pumpage will continue the decline in artesian head, ultimately reaching a depth which will make pumping cost excessive. The Water Department is considering recommendations to be made soon calling for diversion of 35 to 50 mgd. from the San Jacinto River and continuing the use of groundwater but exploring wells to the north.

*TOLEDO, OHIO*—The Lake Erie $9,000,000 water supply project, now 88 percent complete, is scheduled to be in operation by May 1. Principal elements are an intake structure, a 108-in. intake conduit 3 miles long, a raw water low-lift pumping station, a 9-mile 78-in. pressure main to a new 80-mgd. purification plant, a 35-mgd. filtered water reservoir, a high-lift pumping station and a new crosstown main connection to all existing large mains.

*SANDUSKY, OHIO*—On Sept. 30, 1940, the 9-mgd. Big Island Lake Erie water supply was put into operation, replacing an old purification plant and pumping station taking its supply from polluted Sandusky Bay. A submerged crib in 25 ft. of water 3,000 ft. from shore was connected to a new low and high service pumping station by a 42-in. intake pipe at the new filter plant. With a trunk main under construction total cost of the improvements to the system will be $1,000,000.

*MUSKEGON HEIGHTS, MICH.*—Some 500 men are at work on the $1,200,000 water supply improvements scheduled for completion this year. Items involved are a 30-in. intake pipe extending to a crib 4,620 ft. into Lake Michigan, 3,540 ft. of which is laid; a 10-mgd. low-service pumping station to be completed soon; a 7-mgd. filter plant to be completed in May; 3,000 ft. of 30-in. pipe to the filters; and 3½ miles of 30-in. line to the recently completed 12-mgd. high-lift pumping station. Of the latter line 11,000 ft. is already laid.

*MINNEAPOLIS*—The 120-mgd. water softening plant, consisting of twelve double-cone precipitators, stabilization chambers, sludge concentrators, chemical storage and a two-way low-service pumping system, will be completed this spring.

*WILMINGTON, N. C.*—A survey of all available sources of water for the city is now in the making, following approval of a $1,000,000 expenditure for a new supply. High tides backed up salt water into the Toomar's Creek Reservoir in October and rendered the present supply unfit, thus creating a serious emergency.

*HARRISBURG, PA.*—A new gravity water supply of about 17-mgd. capacity was completed in September, 1940, and will shortly replace a filtered and pumped supply from the Susquehanna River. This project, costing $2,800,000, involves a 90-ft.-high earth storage dam, and 22 miles of concrete and steel pipe of 42-in. diameter.

*CLEVELAND*—Preliminary work on a 200-mgd. water supply from Lake Erie to supplement the 135-mgd. supply from the Baldwin filtration plant has been under way since October, 1938, using WPA forces. Excavation for the first treatment-plant units—a screen well, a filtration basin and six coagulation basins—has been completed. The screen well, with a diameter of 103 ft. and a depth of 110 ft., ranks as one of the world's largest.

*WICHITA, KAN.*—Largest cement-lined, centrifugal cast-iron pipe yet made (48-in. dia.), and the first pipe of such size to be designed for exact load conditions, external as well as internal, was used in the new 30-mile water supply line. In addition to the pipeline the $2,425,000 investment in a water supply includes the construction of 25 wells to produce 32 mgd. and a filtration plant with iron-removal facilities.

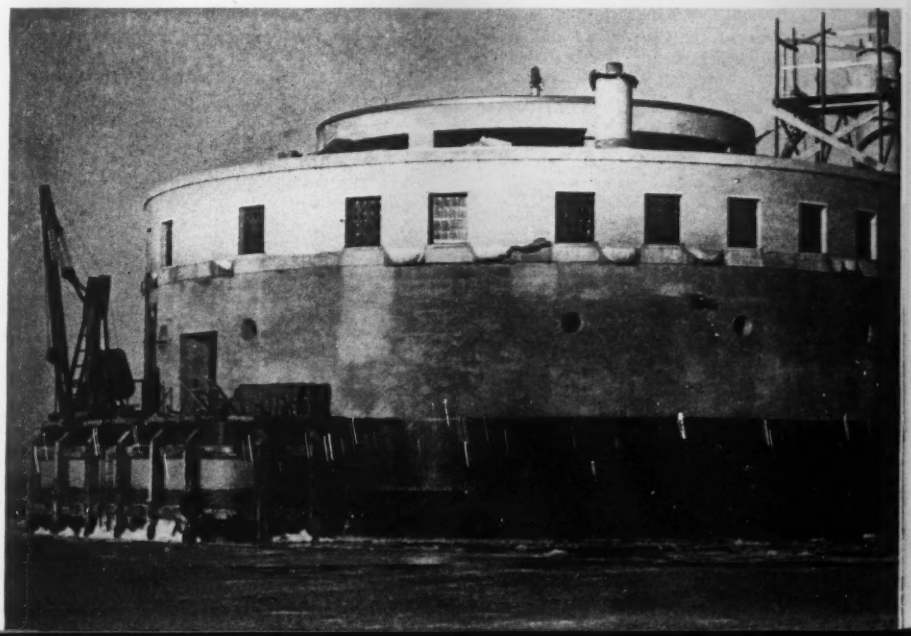
*BETHLEHEM, PA.*—To replace a supply obtained from deep wells and the polluted Lehigh River, $3,900,000 was spent to develop a mountain supply 25 miles from the city. The project included a rock and earthfill dam 140 ft. high, 2 miles of tunnel, a 23-mile concrete pipeline, 2 miles of smaller pipeline and 3 structures for control and operating purposes. Major work was completed at the end of the year.

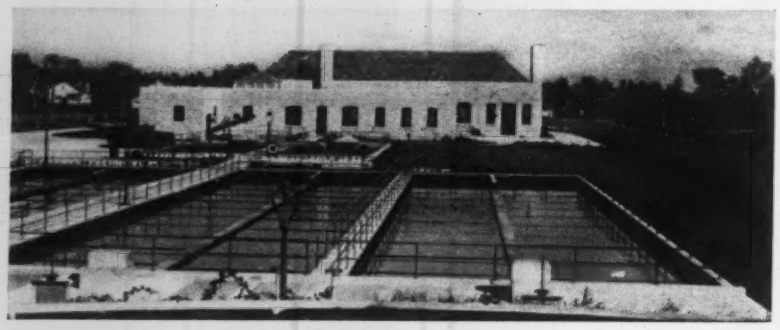
*COLORADO RIVER AQUEDUCT*—On the Colorado River Aqueduct project work went forward during the year on the distribution system and on a modern water softening and filtration plant. The distribution system, involving more than 150 miles of tunnels and large pipes, was more than 90 percent completed at the end of 1940. The main line of the aqueduct terminating in Lake Mathews, formerly known as Cajalco Reservoir, was completed in 1939. Testing the five pumping plants along the aqueduct has stored some 96,000 acre-ft. of water (90 percent total capacity) in Lake Mathews. Delivery of aqueduct water to the 13 cities of the Metropolitan Water District of Southern California is scheduled to begin next summer. Total costs of the project are now expected to be less, by $22,000,000, than estimates on which the district's 1931 bond issue was based.

*RALEIGH, N. C.*—An 8-mgd. filter plant was placed in service this year to supplement other improvements including an elevated steel water tank and additional distribution system facilities.

*MONO BASIN*—On the Los Angeles Aqueduct, Mono Craters Tunnel and the conduit leading from Grant Lake (capacity 48,000 acre-ft.) to the tunnel were ready for service early in the year. In December Grant Lake Dam and the conduit connecting Leevining Creek to Grant Lake were finished. The Long Valley Dam is completed with the exception of placing a small amount of rock on the upstream slope and completing the outlet control works. Impounding water in the 163,000-acre-ft. Long Valley Reservoir is to begin early in 1941.

*This is not a fort for national defense but an intake crib for Toledo's Lake Erie supply.*





*Resembling a swimming pool at the country club, this is the Kenosha, Wis. sewage disposal works. The plant is located in a park and meets the highest esthetic standards.*

# SEWAGE DISPOSAL

*CRANSTON, R. I.*—Work upon this city's $6,000,000 sewage disposal project, including sewers and a treatment plant, was started June, 1939, using WPA labor. About 50 miles of sewers and 20 miles of service connections have been built. Seven pumping stations and a treatment plant are now under construction. A maximum of 2,700 men have been employed at one time on this job.

*NEW YORK CITY*—Consistent advancement marked this major sewage treatment program. There are now 13 works in operation, of which nine are older plants (treating 115 mgd.) that will eventually be superseded. Four newer plants, namely, Ward's Island, Coney Island, Tallman's Island, and Bowery Bay, are treating about 275 mgd. Roughly 39 percent of New York's sewage is being treated, the new plants accounting for 27 percent of the flow. No plants were completed in 1940 but construction has progressed at five locations. This includes a 35-mgd. addition to the Coney Island works, facilities for final treatment by the activated-sludge process (40 mgd.) at the Bowery Bay plant, construction of aeration tanks, settling tanks and sludge digestion tanks (65 mgd.) at Jamaica, contracts for the preparation of site at the 26th Ward plant (65-mgd. activated sludge) and all contracts for the City Island and Hart Island (1.5 mgd.) plants. It is expected that all these new works will go in operation in 1941-42. This year's capital outlay budget provides about $6,000,000 for new construction with the possibility of some increase. Now under design are new plants at Owl's Head (200 mgd.), Newtown Creek (280 mgd.), Hunt's Point (200 mgd.), and Rockaway (30 mgd.)

*GARY, IND.*—Costing $1,890,000, a 40-mgd. combined activated-sludge sewage treatment and garbage grinding plant was dedicated in September. Addition of garbage to sludge for digestion is estimated to produce byproduct gas with an annual value of $13,000.

*BOSTON, MASS.*—Preliminary plans for $10,000,000 construction program, including a treatment plant, force main, and marginal conduits are being prepared by the Boston Metropolitan District Commission.

*LOS ANGELES*—A board of consulting engineers has recommended the expenditure of $32,000,000 in order to cope with the city's sewage disposal needs. Of this total some $10,000,000 is for sewerage improvements, and the balance for treatment facilities. The improvements are listed in two classifications: (a) immediate and (b) deferred. The program for immediate needs will involve an expenditure of $17,600,000.

*SPRINGFIELD, MASS.*—Notable additions to pollution abatement projects in the Connecticut River Valley were the two disposal plants placed in operation by Springfield. The 30-mgd. main treatment works, which cost $1,175,000, provide plain sedimentation with sludge digestion, filtration and incineration. In order to bring sewage to the plant it was necessary to build a $180,000 underriver pipeline. The other new plant, a 3-mgd. sedimentation and sludge digestion plant, cost $210,000.

*MARION, IND.*—In July an $806,000 compressed-air activated-sludge plant was completed. The plant handles domestic and cannery wastes and includes a garbage grinder and sludge gas engine.

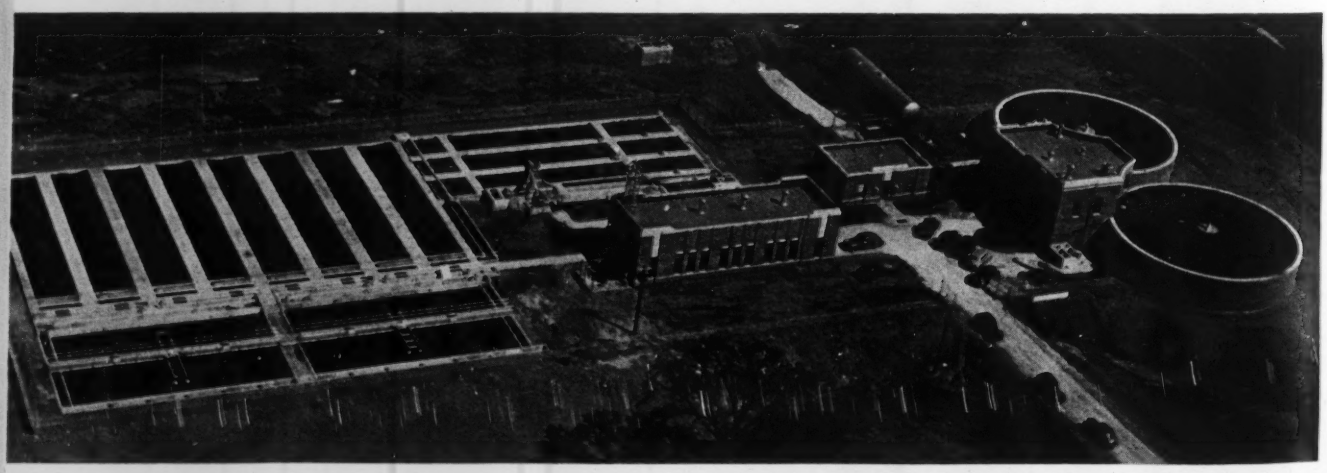
*HAMMOND, IND.*—The $3,250,000, 30-mgd. sewage plant is nearly complete. The project consists of 14 miles of intercepters, three outlying pumping stations, a main station, pre-aeration, primary settling, aeration, final settling, sludge digestion, sludge drying bed and a power building.

*PHILADELPHIA SEWAGE*—The Philadelphia Authority, created in September, 1938, to finance and build sewage disposal facilities, withdrew shortly after a new administration took over in January, 1940. The administration decided, as in the case of waterworks improvements, that the city itself would undertake to handle this project. Consulting engineers made a report on proposed additional facilities but no action has as yet been taken. In the meantime, the Supreme Court of Pennsylvania invalidated the proposed method of financing by sewer rental. The project will be delayed until the latter part of 1941, when the matter will be placed before the voters: in the interim it is said that a new method of financing will be developed.

*FORT WAYNE, IND.*—A $5,200,000 PWA sewage treatment project consisting of storm relief sewers, intercepting sewers and an activated sludge sewage disposal plant was completed in November.

*LOUISVILLE, KY.*—The sewer commission in this city has received a report stating that it would cost $5,700,000 to provide treatment facilities. Work would include a $4,100,000 river interceptor sewer and $1,600,000 for the treatment plant.

*Marshalltown, Iowa built this activated sludge works for the treatment of domestic and packing-house wastes.*



*CINCINNATI, OHIO*—Plans and specifications have been completed for the Little Miami sewage works, which is designed to serve 136,000 people located in the easterly section of the city. Treatment processes include plain sedimentation, sludge digestion, filtration and incineration. Intercepting sewers are now under construction. In the Mill Creek district comprehensive studies for collection and treatment of sanitary sewage and industrial wastes are under way; the population to be served in this area is 540,000.

*KENOSHA, WIS.*—Located in a park and of architecture in keeping with the site, a $1,000,000 separate-sludge-digestion plant was put into operation last fall. Digester gas is used to produce power for pumping. The treatment provides sedimentation only, but the effluent is chlorinated during the bathing season.

*CHICAGO*—Some 29 contracts totaling $2,162,000 were awarded by the Sanitary District of Chicago with $615,000 of work completed and the balance carried into 1941. Principal items were blowers and boilers for the extension of the Southwest sewage treatment works to 500-mgd. capacity. New contracts for $5,000,000 of work are scheduled for completion this year with an equal amount in 1942 to increase the capacity of the Southwest works to 900 mgd. In 1940 the total treated by all plants averaged 923 mgd. Chicago's total investment in sewage disposal facilities (as of June 1) was $165,106,520.

*ROCK ISLAND, ILL.*—A $2,900,000 combined sewage and garbage disposal project was completed in June. Intercepters and relief sewers serve 1,100 acres. Stormwater is lifted with gas-engine-driven pumps of 250-mgd. capacity, the gas being a by-product from sludge and garbage digestion. Processes include sedimentation, magnetite filtration, digestion, gas storage, sludge filtration, incineration of sludge and garbage, and garbage grinding.

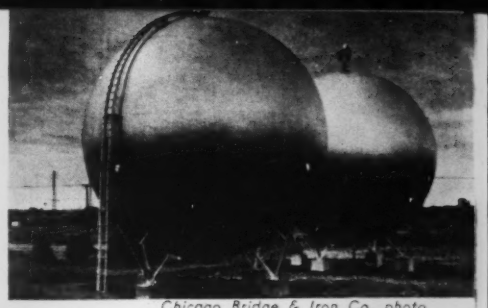
*MARSHALLTOWN, IOWA* — Costing $662,000, a compressed-air activated-sludge plant for domestic and packing plant wastes (equivalent 89,500 total population) was completed in May.

*WISCONSIN RAPIDS, WIS.*—Extensive rock was excavated for the $872,000 sewer system and 3½-mgd. sewage disposal plant recently completed comprising primary treatment with separate sludge digestion, flocculation and chlorine contact chambers, sludge and garbage incineration.

*DALLAS, TEX.*—A $1,500,000, 25-mgd. sewage disposal plant of the trickling-filter type was completed in April. The plant provides screening, grit removal, grease skimming and odor control, primary and final settling and treatment with Imhoff tanks and trickling filters.

*SOUTH ST. PAUL, MINN.*—In October a $1,100,000 treatment project for the city of 12,000 population and packing plant wastes (10 mgd.) from Swift, Armour and the Union stockyards was put into service. Treatment facilities include grit removal tanks, grease removal, primary, and final sedimentation, six high-rate filters with facilities for backwashing with air and water, and effluent storage for backwash.

*NEW HAVEN, CONN.*—Construction of a 14-mgd. sedimentation and sludge incineration plant, installation of a main intercepting sewer and the addition of sludge incinerating facilities at an existing disposal works were completed at a cost of $1,200,000.



Chicago Bridge & Iron Co. photo

***Power from sludge gas brings new economies in disposal plant operations. Here are Rock Island's tanks for storing gas.***

# WATERWAYS

*NEW YORK STATE BARGE CANAL*—Connecting Lake Ontario with the Hudson River, the New York State Barge Canal is being deepened between locks to 14 ft., widened at bends, and improved to provide an overhead clearance of 20 ft. The work, begun in 1935, is about 70 percent complete. Of the 184 miles of waterway to be deepened, about 167 miles has been completed and the remainder is expected to be finished by 1942. Total cost of the improvement is estimated at $27,000,000.

*RICHMOND DEEPWATER TERMINAL*—With the city of Richmond, the PWA, WPA, and the Virginia State Highway Department having spent a combined total of $3,526,000, the city's new deepwater terminal on the James River was placed in service early this fall. Terminal facilities consist of a concrete wharf 1,250 ft. long, two concrete warehouses, and 15,000 sq. ft. of shed. Also provided is a turning basin with a depth of 25 ft., a bottom width of 700 ft., and an overall length of about 1,600 ft. Since 1930 the War Department has spent $3,434,000 for improvement of the 87 miles of the river between the terminal and the Atlantic Ocean.

*FORT PECK DAM*—Oct. 11 the job of placing 122,700,000 cy.yd. of fill for the $122,900,000 Fort Peck project on the Missouri River in Eastern Montana was completed. All but 540,000 cu.yd. was placed by hydraulic methods. Work is still underway on placement of the gravel blanket and stone riprap on the upstream face, construction of a powerhouse at the outlet of No. 1 diversion tunnel, and installation of control machinery at Tunnel No. 4.

*CHESAPEAKE & DELAWARE CANAL*—All work on widening and deepening of the canal to a minimum width of 250 ft. and depth of 27 ft. has been completed with the exception of widening at sharp bends. Stabilizing a section of the bank by grading the slopes and installation of a drainage system was undertaken and is expected to be completed in 1941. The wreckage of a lift bridge at St. Georges, Del., has been removed and construction of a new high-level highway bridge is under way.

*GULF INTRACOASTAL WATERWAY*—To provide a minimum depth of 9 ft. over a minimum bottom width of 100 ft. from St. Marks, Fla.. westward to Corpus Christi, Tex.—a distance of 1,009 miles—the Gulf Intracoastal Waterway is well advanced. The section from Corpus Christi to Port O'Connor, Tex., has been completed; the portion between Port O'Connor and Freeport, Tex., is under construction and will be completed about July, 1941; and the length from Freeport to Carabelle, Fla., is complete. Construction of the section from St. Marks River to Carabelle has been authorized but not yet undertaken because of local interests failing to comply with requirements of local cooperation.

*CALCASIEU RIVER AND PASS*—Estimated to cost $9,260,000, dredging is about 96 per cent complete for a channel 30 ft. deep with a bottom width of 250 ft. from Lake Charles, La., to deep water in the Gulf of Mexico—a distance of 40 miles. Excavation totals 50,000,000 cu.yd. Work includes extension of the existing jetties in the Gulf of Mexico to the 15-ft. contour, with contracts already awarded for placing 220,000 tons of stone in extending the jetties to the 12-ft. contour.

*UPPER MISSISSIPPI RIVER* — When Dam 24 at Clarksville, Mo., was placed in operation March 13, the 9-ft. canalization of the Upper Mississippi was considered virtually complete. The project cost $170,000,000 and extends from the mouth of the Missouri to Minneapolis, a distance of 658 miles. Flow is controlled by 26 low-head dams with locks. Average difference between upper and lower pools is 12.5 ft. with the maximum the 38.2-ft. lift at Keokuk Dam, which is part of the system, although completed in 1913 as a private power project.

*LAKE OKEECHOBEE*—Enlargement of the levees along the south and east shores of Lake Okeechobee in Florida to protect adjoining land from flooding in time of storm was begun in 1938 and has been in progress since that time. To date, about 14 miles of levee have been enlarged and strengthened with soft rock dredged from the lake bottom and pumped into the fill. Rock for the levee enlargement is being dredged from the navigable channel in the lake. To the west of the lake, the Caloosahatchee River has been straightened and deepened and new locks and control gates have been built. Similar work on the St. Lucie Canal, to the east of the lake, is nearing completion. This work will provide a minimum depth of 10 ft. in the waterway across Florida.

# FLOOD STORAGE AND CONTROL

*KANOPOLIS DAM*—Contract was let in November for the Kanopolis Dam, an army engineer flood-control project southwest of Salina, Kan., on Smoky Hill River. The dam, 3 miles long and 125 ft. high, will contain 15,000,000 cu. yd. of rolled fill. It will require 19,000,000 cu. yd. of excavation. A 14-ft. ½-mi. diversion and outlet tunnel, being built under a separate previous contract, was more than half finished at the end of the year.

*JOHN MARTIN DAM*—Construction of the combined rolled-fill and concrete dam on the Arkansas River at Caddoa, Colo., an army engineer flood-control project designated as the John Martin Reservoir, was started in midsummer with the award of a $7,160,000 contract. By the end of the year much of the foundation of the earth embankment had been stripped, and the upstream cofferdam, containing a sheetpile cutoff as the upper toe of the dam, was well along. The dam will contain 220,000 cu. yd. of concrete in the spillway section and 5,915,000 cu. yd. of earthfill. A 20-mile relocation of the A. T. & S. F. Ry. around the reservoir to the south, involving three high bridges, was put into service early in 1941.

*OHIO VALLEY*—In the upper Ohio River valley the end of the year saw two main dams—Crooked Creek and Tionesta—practically completed, and Mahoning Dam well along, Youghiogheny Dam started. The Johnstown channel rectification work was, for the most part, finished at the end of the year. Along the main river local protection works were built at many locations, including those at Wellsville and Ironton, Ohio, Huntington and Kenova, W. Va., Louisville and Paducah, Ky., Evansville and Lawrenceburg, Ind., and Golconda, Ill. At Cincinnati plans were announced for the protection of the Mill Creek valley with the work involving concrete floodwalls and a barrier dam.

*DENISON DAM*—As the year ended the $48,290,000 Denison Dam flood-control and power project on the Red River near Denison, Tex., was about 16 percent complete. The work was begun in September, 1939, and included a 15,200-ft. earth embankment of the rolled fill type, outlet works, a concrete paved spillway, and a powerhouse to have an initial installation of two 35,000-kw. units and provisions for ultimate installation of three additional 35,000-kw. units and provisions for ultimate installation of three additional 35,000-kw. units. To control the runoff from 38,290 sq.mi., 40 percent of the Red River's drainage basin, 5,825,000 acre-ft. of storage will be provided.

*LOWER RIO GRANDE*—This country and Mexico continued the construction of the international flood-control works along the river in the Gulf region. On the United States portion, which is 60 percent completed, 40 miles of river levee, 55 miles of floodway levees and 25 miles of floodway channel have been constructed or improved. Work is under way on the North Floodway and the Rio Grande levee. The United States portion will cost approximately $9,390,000.

*RIO GRANDE CANALIZATION*—During 1940 the U. S. Section, International Boundary Commission, continued the canalization work on the 100-mile sector of the river above El Paso, Tex. This $4,620,000 project, designed for the control of irrigation waters from the storage reservoirs to the international boundary, includes the completed American diversion dam near El Paso, nine river bridges for which a contract was recently awarded, and the canalization feature now under way on which parallel levees have been completed along 50 miles of river. The project is 65 percent completed.

*NIMROD DAM*—The $4,000,000 concrete flood-control dam being built on the Fourche La Fave River near Nimrod, Ark., by the U. S. Engineers was 40 percent complete at the end of 1940. Concreting operations have been completed in the first cofferdam and preparations are being made to begin the work's second stage.

*MARSHALL FORD DAM*—Construction of the $23,000,000 high (270 ft.) dam, major flood-control feature of the Colorado River project in Texas, is 80 percent completed. The dam, which will store 3,000,000 acre-ft. for flood control, power and irrigation is being built by the U. S. Bureau of Reclamation. Final contracts awarded in August were for 464,000 yd. of concrete and 1,630,000 yd. of earth and rock embankments. Work completed in 1939 by previous contracts for the 190-ft. dam included 1,400,000 yd. of concrete and 83,000 yd. of earth and rockfill. The two 26-ft. diversion conduits were closed in September and storage (now 125 ft. deep at the dam) began to permit early power production.

*MUD MOUNTAIN DAM*—Contract for an earthfill, flood-control dam 425 ft. high at Mud Mountain on the White River in Washington was awarded late in 1939. A few months later it was discovered that the available materials were unsatisfactory for such a fill. In July, 1940, it was decided to change the design to a dumped rockfill, using a rolled fill only in the core. During 1940 work was completed on two diversion tunnels, stream diversion was made late in August, and streambed excavation was then begun; canyon walls had been stripped previously. The concrete spillway is nearly completed.

*SOUTHERN CALIFORNIA*—Flood protection work advanced steadily during the year throughout Los Angeles and Orange counties, principally under supervision of the U. S. Engineer Department. Progress on the major dams is as follows:

*Sepulveda Dam*—Good progress was made on this 3,000,000-cu. yd. rolled earthfill dam for flood control on the Los Angeles River just above Sepulveda Blvd. This structure will have a total length of 15,560 ft., is curved in plan, and will have a maximum height of 53 ft. The dam is estimated to cost $7,220,000.

*Prado Dam*—This rolled earthfill structure under construction on the Santa Ana River in Orange County was nearing completion at the end of the year. Concrete spillway and outlet works are completed and the structure can now be used for taking the peak off of floods.

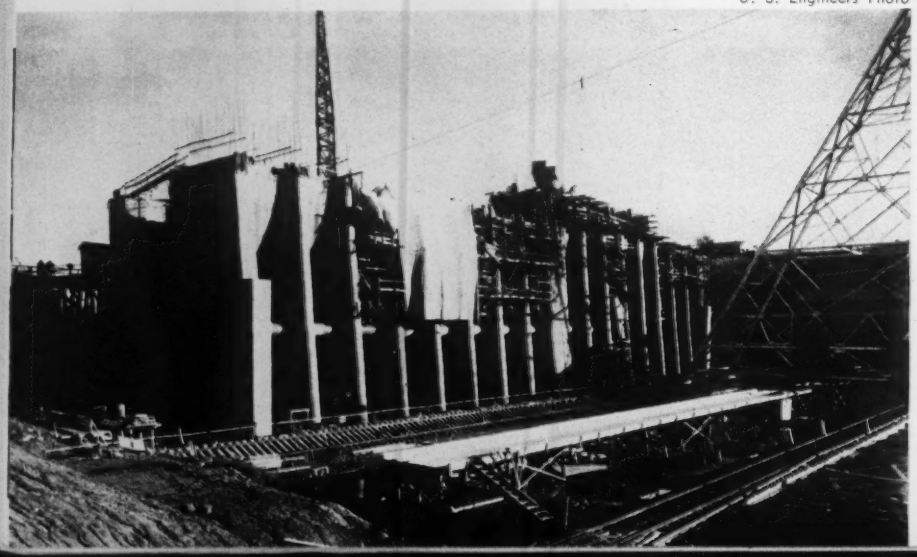
*Hansen Dam*—This structure was dedicated Aug. 17, completion having been 15 months ahead of schedule.

*Other Southern California Dams*—Construction is well under way at Brea and the Fullerton flood-control dam is practically complete. Work has been done on plans and estimates for the San Antonio and San Juan dams. Surveys and detailed plans were completed for Santa Fe Dam on the San Gabriel; bids to be invited soon.

*LOWER MISSISSIPPI RIVER*—Upper and lower guide levees on the Morganza floodway have been completed, and embankment approaches to a proposed high-level bridge over the floodway to carry a state highway and the Texas & Pacific Ry. have been started. Sardis Dam in the Yazoo River basin is complete, and work has been started on Arkabutla Dam in the same basin. On the Atchafalaya River the east main levee is about finished, and the west levee is nearing completion. Work was continued on the new Wax Lake outlet to the southwest to provide for greater discharge capacity from the Atchafalaya.

*Rapid advancement marks construction of Denison Dam intake structure.*

U. S. Engineers Photo



*SARDIS DAM*—Affording protection to 3,000,000 acres of rich lowlands, the $15,000,000 Sardis Dam project on the Little Tallahatchie River in Mississippi was dedicated Aug. 8. The 16,800,000-cu. yd. earthfill structure has an overall length of 14,500 ft. wth a maximum height above river bed of 117 ft.

*PENSACOLA DAM*—Longest multiple arch dam in the world, the $22,500,000 Pensacola project on the Grand River in northeastern Oklahoma was completed in October. The dam, which is 152 ft. maximum height with a 20-ft. roadway and a 4-ft. sidewalk along its crest, consists of 51 arch sections, each of 60-ft. span between hollow buttresses, to make the overall length of the arch section 4,284 ft.

*MERRIMACK VALLEY FLOOD CONTROL*—Two dams for control of floods in the Merrimack River valley were under construction in 1940.

*Franklin Falls Dam*—Construction of this 2,800,000-cu. yd. rolled-fill dam on the Pemigewasset River above Franklin Falls, N. H. was begun in November, 1939. The dam will be 130 ft. high and 1,700 ft. long. At the end of the year the work was 47 percent complete.

*Blackwater Dam*—Work on Blackwater Dam on the Blackwater River at Swett's Mills, N. H. was begun in April, 1940, and the structure was 70 percent complete at the end of the year. It is a combined concrete and rolled-fill dam, 1,100 ft. long and 75 ft. high.

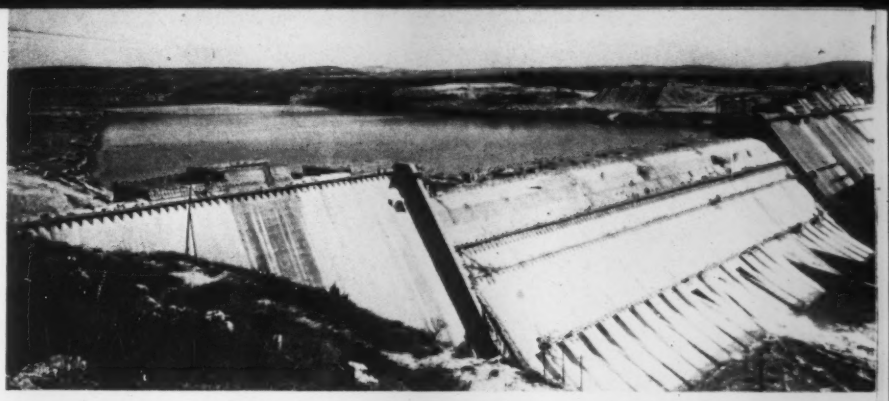
*CONNECTICUT RIVER FLOOD CONTROL*—Three dams, all on tributaries, were under construction during 1940 for control of floods in the Connecticut River valley.

*Surry Mountain Dam*—This 900,000 cu. yd., rolled-fill structure, 1,670 ft. long and 86 ft. high, was started during the summer of 1939 on the Ashuelot River in New Hampshire. Approximately 500,000 cu. yd. of fill have been placed, and the concrete work on the spillway and outlets is 25 percent complete. The dam will be completed about Oct. 1, 1941.

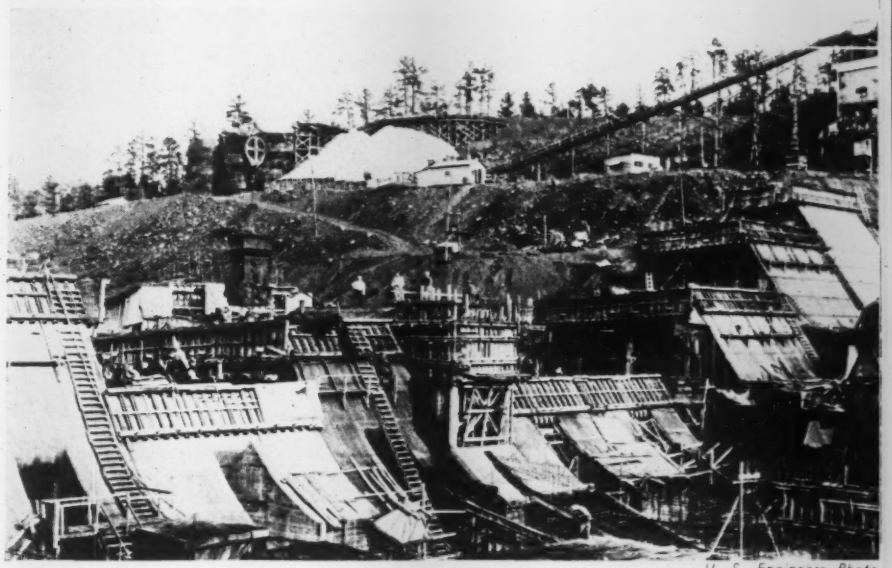
*Knightsville Dam*—During 1940, about 750,000 cu. yd. of hydraulic fill were placed, the outlet tunnel completed, and 37,000 yards of concrete placed in the spillway and gate structure. The dam, located on the Westfield River in Massachusetts, when completed, will be 1,200 ft. long and 160 ft. high, and will contain 1,000,000 cu. yd. of hydraulic and rolled fill. Completion of the dam is scheduled for November 1941.

*Birch Hill Dam*—Contract was awarded late in 1940 for construction of this dam on the Millers River in Massachusetts. It will be of rolled-fill construction, 1,400 ft. long and 56 ft. high, containing 260,000 cu. yd. of fill. Construction of the dam requires relocation of 4.5 miles of the double-tracked main line of the Boston and Albany R.R. At the end of the year 40 percent of the rolled fill in the dam had been placed, and the relocation of the railroad was 10 percent complete. The dam is scheduled for completion in October.

*Dikes and Flood Walls*—The construction works along the Connecticut River was actively prosecuted during 1940 at Northampton, Chicopee, Holyoke, West Springfield and Springfield, Mass., and East Hartford and Hartford, Conn. All the local protection works at Northampton, Chicopee and Springfield will be completed this year. The remaining work at Hartford and East Hartford is expected to be placed under contract early in 1941 if funds are made available. For Holyoke and West Springfield, authorization of additional funds will have to be made to permit completion of the protection works.



*Water upstream from Marshall Ford Dam, which was 80 percent as the year ended, was 125 ft. deep when this recent view was taken.*



U. S. Engineers Photo

*This shows operations early in December in the first cofferdam at the Nimrod Dam site. Soon afterward the second stage of the work was begun.*

*ST. FRANCIS BASIN PROJECT*—Construction was continued on the Wappapello earth dam on the St. Francis River in southeastern Missouri, and the diversion tunnel was started for the Clearwater Dam. Levee construction in the St. Francis basin has been continued throughout the year.

*SUSQUEHANNA RIVER*—Progress on flood-control work is as follows:

*Indian Rock Dam*—Work continued through the year on the 1,000-ft.-long, 80-ft.-high, rolled-earth dam on Codorus Creek southeast of York, Pa. The structure, containing 290,000 cu. yd. of earthfill and 190,000 cu. yd. of rock, is about 55 percent complete.

*Codorus Creek Improvement*—A contract was awarded in July, 1940, for 4.35 miles of channel improvement through the city of York. This work involves about 990,000 cu. yd. of common channel excavation, 249,000 cu. yd. of levee fill, 130,000 cu. yd. of rock channel excavation, and riprap and concrete structures. Construction is well under way on all parts of the work.

*Whitney Point Dam*—This 2,600,000-cu. yd. rolled-fill structure on the Otselic River near Whitney Point, N. Y., is now about 65 percent complete. Diversion of the stream through the 13-ft. concrete-lined tunnel and construction of the closure section of the embankment is scheduled for 1941.

*Levees and Flood Walls*—Three systems of levees, a pumping station, and related works are under way in the vicinity of Kingston and Wilkes-Barre, Pa., with construction varying from about 10 percent to 85 percent complete. At Binghampton, N. Y., local improvements involving 23,000 ft. of levees and a mile of new and raised flood walls are two-thirds complete on $750,000 of contracts. On tributaries of the Susquehanna at Hornell and Corning, N. Y., about $2,100,000 of contract work is in progress on flood walls and channel improvements with completion expected in 1941. Contract for a project at Williamsport, Pa., on the West Branch of the Susquehanna was scheduled for award during January, 1941.

Bureau of Reclamation Photo

*Concreting operations at Shasta Dam began in July and at year's end 500,000 cu. yd. had been placed by seven cableways radiating from 460-ft. head tower at right.*

# LAND RECLAMATION

*CENTRAL VALLEY PROJECT*—Major features of the $228,000,000 Bureau of Reclamation Central Valley Project all made progress, reaching, by the end of 1940, a total of $82,000,000 expended or under contract. Total employees at the year's end, 5,700; labor expended on the project to date 18,000,000 man-hours.

*Kennett Division*—Contractor's plant at Shasta Dam, including a 9-mile belt conveyor and a 460-ft. head tower for 7 radial cableways, was completed. First concrete was placed in July and some 500,000 cu.yd. out of a total of 6,000,000 cu.yd. to be needed was in place before the year's end. River diversion was made in August. Late December rains overtopped the cofferdams and halted work in the river bottom for the winter.

*Railroad Location*—On the 30-mile railroad relocation around Shasta Reservoir, all grading, all twelve tunnels and six of the eight major bridges were completed, and track was laid on about 25 miles of the new line. Of the 15-mile highway relocation, a 2½-mile section was finished and opened to traffic. The remaining 12½ miles is under contract. For a description of the Pit River Bridge see "Bridges."

*Delta Division*—In August the partly completed Contra Costa Canal, which has a 350-cfs. initial capacity, began delivering water to the city of Pittsburg several years ahead of schedule. Of the 46-mile total length of this canal, 29 miles are complete and bids for another 8½ miles were called for January. Engineering studies are under way on the Delta Cross Canal to connect Sacramento and San Joaquin Rivers and on the San Joaquin pumping system on the west side of San Joaquin valley.

*Friant Dam*—Contractor's plant, including a 3-mile aggregate railroad, was assembled and put in operation at Friant Dam and by the year's end, 140,000 cu.yd. of concrete of the 2,200,00-cu.yd. ultimate total was in place. River diversion was made in July. Late December floods exceeded diversion capacity and flowed over low blocks of concrete. On the 37-mile Madera Canal, location was completed and construction started on the first 8-mile section—which is of 1,000-cfs. capacity. On the 160-mile Friant-Kern Canal, location surveys were completed for the first 72 miles.

*GILA PROJECT*—Gravity Main Canal, 21 miles in length, was completed to the site of pumping plant No. 1 near Blaisdell, Ariz. The Fortuna automatic spillway at Station 948 on the canal and a spillway channel connecting the canal with the Gila River, together with two highway bridges, were completed in March. Also work was started in August on pumping plant No. 1. At the end of the year the plant was 41 per cent completed. The contract price is $265,744. The first project lands to be developed comprise 35,000 acres on the Yuma Mesa. The area, to be reached by a 52-foot pumping lift, is adjacent to the Valley division of the Yuma project. Earthwork, canal lining and structures for the "A" and "B" canals and laterals were advertised for bids in December and work will be started early in 1941.

*ALL-AMERICAN CANAL*—Work on the 80-mile All-American Canal, extending from the Imperial diversion dam on the Colorado River, 15 miles above Yuma, Ariz., to the West Side Main Canal of the Imperial Irrigation District's irrigation system in southern California, was completed in July. The first water for irrigation was run through the canal and turned into the East Side Highline Canal of the Imperial system on Oct. 12. Excavation of the first 43 miles of the 130-mile Coachella Canal was completed in March. A second contract, comprising excavation of canal and diversion and drainage channels, and the building of structures on an additional 47 miles, is in progress. The contract price for this second section is $2,210,813 and the work was 52 per cent complete on Dec. 31. At Drop No. 3 installation of one 7,500-hp. unit was completed and at Drop No. 4 one 13,300-hp. unit. The ultimate installation at the four plants will be 70,200 hp.

*BOISE-PAYETTE PROJECT*—The distribution system for 26,768 acres of gravity lands in the Payette division of the Boise project in western Idaho was completed during the year with irrigation water to be available for the 1941 season. The two branches of the Black Canyon Canal, the 33-mile "A" Line Canal and the 39-mile "D" Line Canal, were completed in August. Laterals under these canals were finished in July and wasteways at tunnels Nos. 2 and 7 on the Black Canyon Canal were completed in May. A contract for construction of wasteways at Graveyard Gulch and Langley Gulch was awarded in August and the contractor started work in October. The wasteways were 75 per cent completed on Dec. 31. Additional storage is to be provided in the Cascade Reservoir on the North Fork of Payette River, with a capacity of 700,000 acre-ft. The dam and reservoir sites were explored, detailed investigations made and designs were prepared in order that construction may be started in 1941. The estimated cost of the division is $8,847,000.

*SHOSHONE-HEART MOUNTAIN PROJECT*—Work was continued during the year on construction of the 41,000-acre Heart Mountain division of the Shoshone Project in northwestern Wyoming. For the 28-mile Heart Mountain Canal, 23 miles were completed and a contract for the controlling works and tunnels of the Shoshone Canyon Conduit was 97 percent completed at the end of the year. Construction of a lateral distribution system for the 10,000-acre first unit of the division was started in March and the $240,000 contract was 97 percent completed on Nov. 23, when work was suspended for the winter. A second contract for additional laterals and sublaterals was awarded in October, but this work will not be started until spring. The Heart Mountain division will cost about $6,500,000.

*BUFFALO RAPIDS PROJECT*—An additional appropriation of $560,000 was made available for a 3,000-acre extension to the Glendive division in Montana with government forces excavating the main canal and laterals and building the structures. A second division of the project to cost $1,840,000 was authorized for construction. This will provide for the irrigation of 11,600 acres on the south side of the Yellowstone River in Custer, Prairie and Dawson counties.

*PINE RIVER PROJECT*—Vallecito Dam on Pine River near Bayfield, Colo., was under construction during the entire year and on Dec. 31 was 99 percent completed. Embankment operations were suspended on Nov. 8 on account of weather conditions with 12,000 cu. yd. remaining to be placed. Concrete placing was discontinued on Nov. 17. All other construction work, except installation of high-pressure gates in the outlet conduit, was suspended until spring. The Vallecito Dam will cost $3,200,000 and with its 3,690,000 cu yd. it is the second largest structure of its type to be undertaken by the Bureau of Reclamation.

*TUCUMCARI PROJECT* — This work comprises 45,000 acres in Quay County, in northeastern New Mexico, to be irrigated with water stored in the Conchas Reservoir of the South Canadian River. Construction comprises the 69-mile Conchas main canal, laterals, structures and drains. Two contracts for $562,027 and $1,309,582, respectively, were awarded in January for earthwork, tunnels and structures on the first 25½ miles of the Conchas Canal and work was started in March. These contracts were respectively 68 and 46 per cent completed at the end of 1940. Twenty-three miles of canal were opened up, and work was in progress on an additional 12 miles with a total of approximately 2,500,000 cu.yd. excavated.

*PROVO RIVER PROJECT*—During 1940 the contractor made good progress on the Deer Creek Dam and the structure was 78 percent completed on Dec. 31. About 400,000 cu.yd. remain to be placed in the embankment of the 235-ft.-high rolled earth structure, which will have a crest length of 1,300 ft. and will contain 2,700,000 cu.yd. of material. It is located on the Provo River near Charleston and forms a reservoir of 150,000-acre-ft. capacity. The labor contract price is $4,434,946. In December the Alpine-Draper tunnel, 2.85 miles in length, 6½-ft. in diameter, and one of two tunnels on the 40-mile Salt Lake Aqueduct, was holed through. A contract for 3 miles of the 5.5-mile Duchesne Tunnel was awarded in September. The Provo River Project, comprising the Deer Creek, the aqueduct and Utah Lake divisions, is estimated to cost $15,774,000.

*COLORADO-BIG THOMPSON PROJECT* —Two main features of the $54,300,000 Colorado-Big Thompson project in northeastern Colorado were under construction during the year—Green Mountain Dam and the Continental Divide Tunnel. Green Mountain Dam is to be an earth and rockfill structure 274 ft. high on the Blue River near Kremmling to store 152,000 acre-ft. of water. With a volume of 4,366,000 cu. yd., it is the largest structure of its type so far undertaken by the Bureau of Reclamation. A power plant with two 10,800-kw. units is under construction at the dam. All concrete work on the powerhouse, except the foundations for the outlet valves, was completed in November; future work has been suspended until spring. The $4,226,206 labor contract for the dam and power plant was 44 per cent completed at the end of the year. Embankment placing operations were discontinued on November 3 for the season, with 353,765 cu.yd. of earth and 191,700 cu.yd. of rock having been placed. Work was started in May at the outlet or east portal on the first 1.5-mile section of the Continental Divide Tunnel, which will be 13.06 miles in length and 9.75 ft. in diameter. A second section of tunnel, 1.25 miles in length, at the inlet portal was started in August. These two contracts were respectively 74 and 34 per cent complete.

*KENDRICK PROJECT* — Government forces continued work on the 62-mile Casper Canal in Wyoming, and the lateral distribution system for 35,000 acres in the project's first unit, which lies west of the North Platte River and extends from Alcova to Middle Casper Creek. The first unit of the project is estimated to cost $20,000,000.

*First irrigation water flows in the All-American Canal at Pilot Knob wasteway.*

*DESCHUTES PROJECT*—Crane Prairie Dam, one of two storage dams on the upper Deschutes River in Oregon, was completed in August. Excellent progress was made on the Wickiup Dam and the embankment was 30 percent completed on Dec. 1, when work was suspended for the winter. The outlet works for this dam were completed by contract in November, and the embankment is under construction by government forces using relief labor. The main canal, with an initial capacity of 1,500 cfs., will divert from the Deschutes River and extend northerly for 65 miles to the vicinity of Paxton. It was under construction during the year with government forces, and about 20 miles have been completed, exclusive of structures. Bids were invited in December for the construction of earthwork and structures on a 1½-mile section of the North Unit main canal.

*NEW PROJECTS*—Great Plains projects authorized for construction during the year include Buffalo Rapids No. 2 in Montana, Bismarck in North Dakota, Mirage Flats in Nebraska, Rapid Valley in South Dakota, the 13,400-acre Buford-Trenton in Williams County, N. D., Eden in Wyoming, Newton in Utah, and Mancos in Colorado. Work was started in May on the Buford-Trenton Project on the north side of the Missouri River. The pumping plant, 15-mile main canal, laterals and drains will cost $1,500,000. An appropriation was made available for preliminary work on the $17,465,000 San Luis Valley project in the upper Rio Grande basin in Colorado. The principal construction feature will be the Wagon Wheel Gap Reservoir of 1,000,000 acre-ft. capacity on the Rio Grande. Preliminary work was started on the 500,000-acre-ft. Anderson Ranch Reservoir on the South Fork of Boise River in Idaho. This work, part of the Boise project, will provide a supplemental water supply for 340,000 acres of irrigated lands in the Boise River valley. A power plant of 20,000 kw. is planned. The estimated cost of the dam, reservoir and power plant is $13,100,000. Likewise on the Altus Project in Southwestern Oklahoma work preparatory to actual construction was carried on.

*YAKIMA-ROZA PROJECT*—Roza Dam on Yakima River, a concrete ogee weir about 250 ft. long and 55 ft. high, was completed in January, 1940. Work was in progress during 1940 on the 99-mile Yakima Ridge Canal, wasteways and the first unit of the distribution system. In May 14.1 miles of the main canal was completed under two contracts and an additional 0.2 mile in November, making a total of 40.3 miles completed at the end of the year. Wasteway No. 3 was completed in October, No. 2 in November, and construction of No. 4 wasteway was 29 percent complete on Dec. 31. Construction of the lateral distribution system for the first unit of the division was started in October, and a second contract for laterals and sublaterals was awarded in November. The total estimated cost of the Roza division works is $18,035,000.

*TVA's Kentucky Dam work moves into second stage inside high cellular cofferdam. Nearly completed lock is at the left. Tracks of the Illinois Central, now carried on bridge in foreground, will be moved to dam's top.*

# POWER & IRRIGATION

*TRI-COUNTY PROJECT*—Only remaining work on the $36,000,000 power and irrigation project of the Central Nebraska Public Power and Irrigation District at the end of the year was topping out Kingsley Dam, a 26,000,000 cu.yd. hydraulic fill, placing riprap and completion of the emergency spillway for that structure and final work at two of the pow r houses. The three power plants on the 75-mile supply canal, each with a capacity of 18,000 kw., are under test. Platte River water has been carried 65 miles down the main canal. Early in the spring the 575 miles of main canals and laterals to irrigate 200,000 acres will be put into service.

*BOULDER POWER PLANT*—Eight of the 15 large generating units, each 82,500-kw. capacity, and one of the two small 40,000-kw. units are now in operation in the Boulder Dam powerhouse. Two more large units are being installed, and are scheduled for operation in February, 1941 and July, 1942. The eleventh 82,500-kw. unit was ordered in September. The present installed capacity is 700,000 kw. and the ultimate capacity will be 1,317,500 kw.

*ROSS DAM*—Seattle's latest addition to the chain of power developments on the Skagit River is $6,000,000 Ross Dam, completed in April, 1940, to a height of 540 ft. or El. 1,365. Design of the dam and its top thickness of 66 ft. allow for additional height when more storage is needed. Temporarily a 15-ft. height increase has been effected by a timber crib along the dam's crest. This increases the storage from 75,000 to 100,000 acre-ft.

*PARKER DAM POWER*—Excavation for the power plant was completed by contract in October and construction of the powerhouse is being carried out by government forces. Initial installation at Parker will comprise three 30,000-kw. units now on order, with an additional unit for ultimate installation. In May a contract was awarded for furnishing penstocks for the plant, and the contractor erected a field fabrication plant. Installation of penstock No. 1 was completed with government forces as was a terminal about 4 miles west of Phoenix. A 140-mile, 161,000-v. transmission line from Parker Dam to Phoenix was completed at a cost of $1,500,000 and placed in service Jan. 31, 1940. Power from the Boulder plant allotted to the Metropolitan Water District of Southern California is being temporarily supplied over this line to the Salt River Valley Water Users' Association and the Central Arizona Light & Power Co. to meet a critical power shortage caused by insufficient storage in the four Salt River reservoirs. When the Parker power plant is complete, the line will be supplied from Parker instead of Boulder. A second 161,000-v. transmission line, 120 miles in length, was completed in March to extend from Parker Dam to pumping plant No. 1 of the Gila project near Blaisdell. Surveys of the Phoenix-Tucson line and a 50-mile extension of the Parker-Blaisdell line to Drop No. 4 on the All-American Canal were in progress. Total estimated cost of the Parker power project is $14,860,000.

*GRAND COULEE DAM*—During the year 1,407,900 cu. yd. of concrete was added to Grand Coulee Dam, completing 98 percent of the 11,250,000-cu. yd. total required. The spillway section was advanced to crest height and at the end of the year three of the eleven drum gates were in final stages of installation. A contract was let recently for excavating 1,250,000 cu. yd. of material in the slide area on the left bank that menaces the tailrace. Penstock liners and pump inlet pipes were completed ahead of schedule; station-service units were practically ready for generation of power. In the reservoir area, railway and highway relocation was on the order of 50 percent completion and clearing was more than 80 percent ended.

*BONNEVILLE DAM*—During 1940 construction of the portion of the powerhouse for units 3 to 6 inclusive and installation of units 3 and 4, both 76,000 hp. in capacity, was completed. The manufacture of two 74,000-hp. turbines and two 60,000-kva. generators for units 5 and 6 is nearing completion; installation of these units is to be finished about January, 1942. Construction is under way for the portion of the powerhouse for units 7 to 10, inclusive, which will complete the Bonneville powerhouse. Contracts for the four 74,000-hp. turbines will be awarded soon.

*RIO GRANDE POWER PLANT*—Incorporating three 8,100-kw. generating units, the power plant at Elephant Butte Dam of the Rio Grande project on the Rio Grande near Hot Springs, N. M., was completed during the year by government forces. Unit No. 1 was first operated for construction and camp service in August. The power will be sold in El Paso, Tex., and Hot Springs, Las Cruces, Deming, Central and other New Mexico points. Construction of a 115,000-v. transmission line, 62½ miles in length, from Elephant Butte to Las Cruces was completed Dec. 14.

*SANTEE-COOPER*—All elements of the Santee-Cooper power and navigation project in South Carolina were under way at the close of the year, contracts for the first sections of the tailrace from the Pinopolis power plant to the Cooper River having been let late in the year. The substructure of the powerhouse with its five units totaling 213,000 hp. is well along toward completion, the navigation lock is nearing completion, and Pinopolis Dam, the structure in which the lock and powerhouse are located, also is nearing completion. Dikes around the Pinopolis reservoir are completed, and the diversion channel from the Santee River valley to this reservoir is being excavated. Hydraulic dredges are making good headway on the long hydraulic fill for the 7.1-mile dam across the Santee River and the 3,400-ft. concrete spillway for that dam is well advanced.

*TENNESSEE RIVER*—The Tennessee Valley Authority has now completed and placed in full operation Norris, Wheeler, Pickwick Landing, Guntersville, Chickamauga, and Hiwassee dams. Four major dams and a steam power plant are in varying stages of completion and additional generating equipment is being installed at other dams. The construction status at the various sites follows:

*Kentucky Dam*—For this project,, which is 22 miles above the mouth, concreting of the lock started in June and is nearly completed, the cofferdam inclosing the powerhouse and part of the spillway has been unwatered, excavation is well under way, and a small amount of the embank-

ment work has been done. The cofferdam here is the highest ever used of the cellular type, and employs clover-leaf design for the river sections. Completion of the structure is scheduled for 1945.

*Pickwick Landing Dam*—Two additional 36,000-kw. generating units are now being installed and excavation in the channel below the dam is continuing to provide the desired 9-ft. waterway when the Kentucky Dam pool is filled.

*Wilson Dam*—On this project four additional 26,000-kw. units are being installed.

*Wheeler Dam*—Two 32,000-kw. units will be completed early this year to supplement the two original units.

*Guntersville, Chicakamauga,* and *Hiwassee dams*—These were completed and placed in full operation during the year. Some dredging is being done as part of these projects to improve navigation.

*Watts Bar Dam*—Concreting for this project started Feb. 28, with the lock and one section of spillway now complete and work proceeding rapidly on the last construction stage. Sale of commercial power is scheduled to start early next year.

Also under construction at the Watts Bar site is a 120,000-kw. steam generating plant which was authorized July 31. Concrete foundations were three-fourths complete and 2,700 ft. of the projected 3,600 ft. of 78-in. concrete pressure conduit from the dam for circulating water was in place at the year's end.

*Fort Loudon Dam*—Work has been limited to construction of plant buildings and a careful investigation of the foundations, which are expected to be troublesome. Construction will start in earnest when equipment can be released from Watts Bar Dam.

*Cherokee project*—A site on the Holston River northeast of Knoxville, has been the scene of greatest activity in the Tennessee Valley since the project was authorized July 31. The work is on a 20-month construction schedule, which will see 745,000 cu.yd. of concrete placed, 4,000,000 cu.yd. of earth moved and three 30,000-kw. units installed in a structure 175 ft. high with a total length of about 6,750 ft. of which 1.689 ft. is concrete. Nearly a month ahead of schedule, concrete placing started as the new year began.

*Jeffrey Canyon power plant, one of three similar plants on the main supply canal of the Tri-County Project, has two 13,000-hp. turbines operating under a head of 116 ft.*

Bureau of Reclamation Photo

*Both end sections of Grand Coulee Dam are almost at top height, drum gates are being assembled on the spillway, and almost ready for use are the two station-service power units.*

*TENNESSEE TRIBUTARIES*—The Aluminum Company of America through its subsidiary, the Nantahala Power and Light Co., is constructing two earth and rockfill dams on small tributaries of the Tennessee River high in the Smoky Mountains of western North Carolina. These will supplement the power now available for processing aluminum. Glenville Dam, the unit on the Tuckasegee River, will have the highest head of any dam east of the Rockies, 1,215 ft. The 140-ft.-high dam is now 80 percent complete, and 14,000 ft. of tunnel was more than half finished at the year's end. Most of the preliminary work has been completed and the diversion tunnel holed through on the other structure, Nantahala Dam being built on the Nantahala River. This dam will be 260 ft. high and will have a crest length of 1,030 ft. A tunnel 28,700 ft. long, on which work is well underway, will carry water to a point where 999 ft. of head is available. This work is scheduled for completion in 1941. No work is in progress at the Fontana site on the Little Tennessee River but the Aluminum Co. has filed, with the Federal Power Commission, a declaration of intent to construct a dam at that point.

# HIGHWAYS, TUNNELS, AIRPORTS & RAILROADS

*QUEENS-MIDTOWN TUNNEL*—Providing for two lanes of traffic in each direction by twin 31-ft. tubes, New York City's $58,000,000 Queens-Midtown tunnel was opened to traffic Nov. 15. This is the first vehicle tunnel under the East River. It is 7,800 ft. in length with the Manhattan approach between 36 and 37 Sts. and the Queens approach opposite 42nd St.

*BELT PARKWAY*—Excepting a short length near Sheepshead Bay, the 33-mile section from Whitestone Bridge, Queens, to Owl's Head Park in Brooklyn of New York City's Belt Parkway was opened to traffic June 29. This work cost $29,000,000 and required 18 months for construction. Now under way is work to extend the non-stop route to the Brooklyn Plaza of the Battery-Brooklyn Tunnel, also under construction. For the latter link, which is 4 miles long and will cost $14,000,000 including land, demolition of buildings was complete as the year ended and about half

*Allegheny Mountain Tunnel on the Pennsylvania Turnpike, which opened Oct. 1*

the foundations were in place. Awarding of contracts for the rest of the work was rapidly being completed by the Triborough Bridge Authority. This is to be an elevated parkway for the major part and will provide three lanes of traffic in each direction as far as Prospect Avenue and two lanes in each direction from there to Owl's Head Park. Work is also well advanced on the short link remaining at Sheepshead Bay. This work, which is to cost $3,000,000, will be paid for by the Triborough Bridge Authority.

*PHILADELPHIA AIRPORT*—Covering 494 acres and costing $10,000,000, this municipal airport seven miles from Philadelphia's city hall was placed in service June 20. The field is laid out so that each of the runways, which vary in length from 4,500 ft. to 5,400 ft. and in width from 150 ft. to 200 ft., can be duplicated with a new parallel runway about 500 to 600 ft. to the side. Late in the year the city asked the federal government for $10,000,000 for further work on the airport and improvement of the thoroughfares leading to the field.

*PENNSYLVANIA TURNPIKE*—The 160-mile superhighway through the Allegheny Mountains between Harrisburg and Pittsburgh was completed and placed in service Oct. 1. Operations appear financially successful and mechanically the road seems to be better than the cars using it as the high speeds possible are causing engine and tire failure with passenger cars. Surveys are being made by the Pennsylvania Department of Highways for an extension of the route into Philadelphia. The legislation creating the Pennsylvania Turnpike Commission and the financial set-up do not permit use of personnel or money for extension. Thus detail plans and construction must await new legislation, which is being vigorously pushed at the state capital.

*MERRITT AND WILBUR CROSS PARKWAYS*—Connecticut has continued construction of superhighways, completing an extension of the Merritt parkway to and across a new Housatonic River Bridge near New Haven. Major sections of the Wilbur Cross Parkway are under construction with a connection from the Merritt Parkway to U. S. Route 1 complete. Some sections in the northern part of the state will eventually be joined. A $4,200,000 bridge and partial bypass project at Hartford, now well into construction, will keep through traffic out of the business area.

*EAST RIVER DRIVE*—Reclamation of New York's East River waterfront on the Manhattan side made rapid advances through 1940. The new drive was completed from 49th St. to 86th St., including two double-decked sections which were roofed to preserve the privacy of an exclusive area. Also in service is a section from 18th St. down to Montgomery St. Work is proceeding in the midtown section with new construction planned to make an express way from 92nd St. to 125th St. Further north along the Harlem River a winding elevated structure was completed which connects the Harlem River Speedway with the 178th St. tunnel connection to George Washington Bridge.

*BATTERY-BROOKLYN TUNNEL*—Ground was broken Oct. 28 for the 2-mile, $57,000,000 connection from Battery Park at the lower tip of Manhattan to Hamilton Ave. in Brooklyn. Approaches and right-of-way will bring the total cost to about $80,000,000, but only the $57,000,000 will be financed out of tolls. Sinking of shafts on both ends of the structure is under way with completion of this work expected in early spring. Bids will be asked in February on the shield-driven section of tunnel required from the Brooklyn shore to a rock ledge. Heavy cast-iron lining for this section is already under contract. Bids will also be asked shortly on the rock tunnel from the Manhattan side and in early summer on the caisson shaft just off Governors Island. This shaft will be sunk about 135 ft., the lower half through rock, to permit tunneling both ways to meet the headings coming from the shores. All construction is expected to be completed in 1944 as no interference from defense priorities is anticipated.

*CHICAGO SUBWAYS*—Tunneling on the 7.7 miles of the first section of double-track subway for the city of Chicago was completed Jan. 10, 1941, when the two shields traveling north through the Loop under State St. finished their run. The Dearborn St. shields finished their work last October. Hand mining methods were used on the 4.6 miles of route on the first section outside the Loop area, and these tunnels were finished last August, along with the Chicago River crossing at State St., which was built by sinking prefabricated tubes into a dredged trench. Construction is now under way on 17 of the 29 stations required, these being built in open cut, as are also the three connections between subway and the elevated lines. Remaining to finish the first section is a 260-ft. open-cut connection between shield tunnels and river crossing at State St. An extension, including a turnback loop, from the south end of the Dearborn St. route westward a half mile to the river, has been authorized.

*CARLTON TUNNEL*—Phenomenal progress has been made in driving the 10x11-ft. Carlton Drainage Tunnel, near Cripple Creek, Colo., from a single portal. The 5-mile mark was reached on Dec. 23, 1940, after 513 working days, an average progress of 50 ft. per day. Driving is largely through hard Pikes Peak granite which requires no ground support. The tunnel will be left unlined. Another mile of main tunnel and 9,000 ft. of laterals remain to be driven to tap and drain the deep workings of the famous gold mines of the Cripple Creek district.

*WINNETKA GRADE SEPARATION*—Grading for the 3-mile cut and the ½-mile fill and most of the bridges on the grade elimination project for the Chicago & Northwestern and Chicago, North Shore & Milwaukee railroads through Winnetka, Wilmette and Glencoe, Ill., were completed in 1940. The building of stations, platforms, signal systems and final track installation will require another five months. An unusual feature of the $3,750,000 project is its financing, the difference between the contributions of the railroads and a PWA grant, and the total cost being met by the Village of Winnetka.

*LONG ISLAND R.R. GRADE SEPARATION*—On two projects the state of New York through the New York State Transit Commission is spending $30,000,000 for the elimination of grade crossings on the Long Island R.R. in the New York City area. At the end of the year $22,000,000 of the work, which was financed solely by the state of New York, was under contract with the entire undertaking about one-third complete. One project is construction of a double-track elevated line from Far Rockaway to Rockaway Park. This is costing $10,000,000 and is slightly over 5 miles long. The other job, slightly less than 5 miles, is known as the Atlantic Ave. project and extends from Jamaica to Brooklyn. This line is being improved as a subway.

*SKYLINE DRIVE*—Construction of the Skyline Drive proper in the Shenandoah National Park was completed in 1937, but in each succeeding year this road has been projected south as the Blue Ridge Parkway to connect the Shenandoah National Park with the Great Smoky Mountain

*Entire Arroyo Seco Parkway at Los Angeles is now in service.*

*State Street steel-tube section for Chicago subways is towed to site for sinking.*

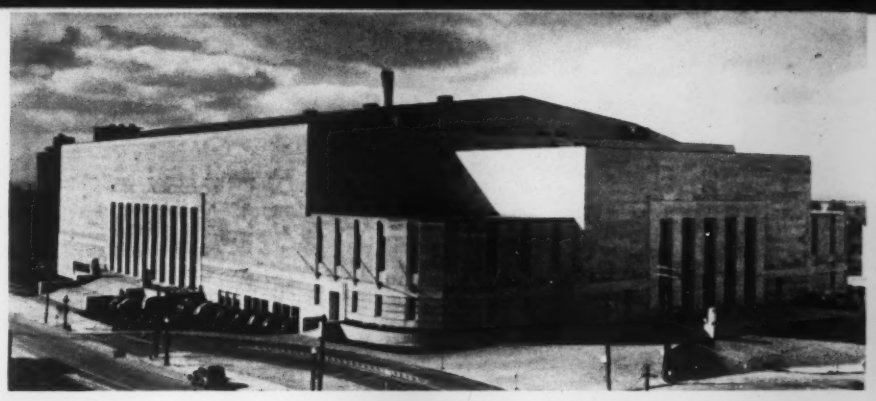
National Park. Including the roads already built in these two parks there is to be a continuous highway—built to high standards, through mountain scenery of great beauty, free from all commercial development and man-made scars—for a distance of 600 miles or from Front Royal to Gatlinburg. Of this 275 miles has been completed with a bituminous surface, and 58 miles has an incomplete stone surface that may be traveled. An additional 58 miles is under construction. The completed section on the northern end, 105 miles in length, is attracting visitors from every Eastern state, nearly 1,000,000 of them in the 12 months ending Sept. 30, 1940.

*ARROYO SECO PARKWAY*—This high-speed motor route from downtown Los Angeles to Pasadena, Calif., was completed and formally opened Dec. 30, just in time for the season's heaviest traffic on New Year's day. Planting and some minor work on bridges will continue some 60 days into 1941. Completion of this route has congested the four Figueroa Street tunnels at its south approach and plans have been made for more capacity here by using the tunnels for one-way traffic only and paralleling them with a new route 40 ft. higher in deep cuts made accessible by a new bridge over Los Angeles River.

*NEW YORK RAPID TRANSIT SYSTEM*—Ownership and operation of the IRT and BMT subway and elevated lines was taken over by the city of New York during the year, giving the city complete control of all rapid transit lines operating wholly in the city. Operation of the 9th Ave. elevated and of the 2nd Ave. elevated above 60th St. was discontinued and demolition of the 9th Ave. is now two-thirds complete. The 2-mile, $59,000,000 Sixth Ave. line of the Independent Division of New York's rapid transit system was placed in service Dec. 15. Only rapid transit now under construction is the extension in Brooklyn of the Fulton St. line of the Independent Division at a cost of $20,000,000. All work is under contract with start of operation expected in 1943.

*WASHINGTON NATIONAL AIRPORT*—The landing field of the civil airport at Washington, which has required 18,500,000 cu.yd. of hydraulic fill, supplemented by 2,000,000 cu.yd. of dry earth, is practically complete. This 729-acre airport can now accommodate emergency landings, but terminal facilities are not expected to be complete until March or April due to weather and special equipment delays. Runway paving, totaling 677,000 sq. yd., has been placed over a base stabilized by use of a small amount of binder and a large amount of mixing. The new port, 10 minutes and 3½ miles from downtown Washington, will replace the present civil airport.

*MOBILE VEHICLE TUNNEL*—Completion of the Bankhead vehicle tunnel under the Mobile River at Mobile, Ala., originally scheduled for July, 1940, has been postponed until March 1941 due to unexpected difficulties encountered on the filled land at the Mobile waterfront.



*Buffalo's new $2,685,000 steel frame auditorium, which has Indiana limestone exterior walls and provides for 165,000 sq.ft. total space, was completed in October.*

# BUILDINGS

*DEFENSE PLANTS*—The large number of munitions plants, airplane factories and shipyards let to contract in the last six months of the year precludes consideration of the present status of each individual job. Also the progress on many of the jobs is rendered meaningless by additions that have increased their original size many times. Furthermore a considerable number of the jobs, notably airplane factories, have been started and completed before they had time to become "major projects" in the sense of being widely known. The most useful information on defense plants would be a picture of the extent and variety of the program. This is supplied immediately following this section in the form of maps and tabular data, which show for the first time where the large building construction jobs of 1940 were located and where they will continue to be carried on in 1941.

*AIR LINES TERMINAL, NEW YORK*—The nation's first union station for air passengers was completed in New York City at the end of the year. Located opposite the Grand Central railroad terminal, it will serve the airport buses of all airlines coming into the city and can handle 72 buses an hour. Its steel framing is completely arc-welded, including some 70-ft.-span 30-ton trusses that carry the waiting room over a theatre. Heavy girders and coverplated beams are other important elements. Buses are handled by ramps and elevators within the building, eliminating street congestion. About 100x200 ft. in plan, the building contains four floors and a penthouse. The structure is air conditioned, and the two basements where buses are stored are equipped with sprinklers.

*WAR DEPARTMENT BUILDING*—This $10,800,000 structure in Washington is the first unit of a larger, $26,000,000, building authorized by Congress. Seven stories high, the present building will provide 310,000 sq. ft. out of an ultimate 1,200,000. The present building, on the northwest corner of the final site, is roughly 62 percent complete. All of the steel framework is up, and limestone facing is more than two-thirds erected. Fifty percent of the bronze sash has been installed and glazed. On the interior, plastering has commenced, and approximately 35 percent of the marble corridors have been completed.

*RACKHAM MEMORIAL BUILDING*—Early fall, 1941, will see the Engineering Society of Detroit housed in the $1,600,000 Horace H. Rackham Memorial Building along with the extension service and graduate classes of the University of Michigan. A 1,000-seat auditorium will be used jointly. Steel and concrete work has been completed and the Georgia marble exterior is well along. The project is made possible through the generosity of the Horace H. Rackham and Mary A. Rackham Fund and Mrs. Mary A. Rackham personally.

*BUFFALO AUDITORIUM*—Seating 14,444 in the arena and 1,200 in the assembly hall, the $2,685,000 Buffalo, N. Y., auditorium was completed in October. The steel frame structure has Indiana limestone exterior walls, provides 165,000 sq.ft. total space, is 260x420 ft. in size, and covers almost an entire block. Pin-connected trusses 258 ft. long and weighing 62 tons were used for supporting the roof. A PWA grant provided 45 percent of the cost.

*HOUSTON OFFICE BUILDING*—Notable among the commercial structures of the year was the 16-story Mellie Esperson Building in Houston, Tex. Some 60x250 ft. in plan, the building is completely air conditioned, special framing design being required to accommodate the ducts.

*WESLEY MEMORIAL HOSPITAL*—The skyline of Chicago's near north side was changed by the completion of the 21-story

*Ninety calendar days are allowed the contractor for constructing 85 Lowry Field buildings requiring slightly less than 2,000,000 b.ft. of lumber.*

Mile High Photo Co.

Wesley Memorial Hospital on the Northwestern University medical school downtown campus. Radiating out from the 21-story center section of steel frame construction are four 16-story wings of reinforced concrete. The entire exterior is Bedford limestone.

*BETHESDA, MD., NAVAL HOSPITAL*—Scheduled for completion late in October this year, the $4,850,000 naval hospital at Bethesda, Md., was 32 percent complete as the year ended. Construction was begun in June 1939 and much of the concrete is in place for the 20-story, 250-ft. central tower and the three- and four-story wings. Precast exposed aggregate slabs are used for trim throughout the main building and for structural outside finish. The hospital is scheduled for occupancy in February, 1942.

*NORTHWESTERN TECHNOLOGICAL INSTITUTE*—Construction of the $5,000,000 home of the new Northwestern Technological Institute at Evanston, Ill., was interrupted on Dec. 2 by a fire that swept through the half-completed building. The structure, 400x600 ft. in plan, and three and four stories high, is largely of reinforced concrete with brick and stone exterior walls. The fire, fed by framework and protecting canvas, damaged more than two-thirds of the parts of the building already completed. Insurance adjustments held up demolition of the damaged sections until late in January, 1941, so rebuilding and completion of the whole building will probably be delayed beyond the opening of the school this fall.

*SOCIAL SECURITY, WASHINGTON, D. C.*—This fall the 540x350-ft. Social Security Building in Washington was completed as was its neighbor, the 540x175-ft. Railroad Retirement Building. Both are of reinforced concrete, six stories high with a penthouse.

*NEW ENGLAND MUTUAL LIFE*—Rapidly nearing completion is the New England Mutual Life Insurance Building in Boston. Occupying 65,000 sq. ft. of ground area and featuring a tower that rises 291 ft. above the curb, the new 200x340-ft. structure will make 7,000,000 cu. ft. of space available, including an assembly hall seating 930 people. Because the location is on a tidal marsh reclaimed years ago by covering with 20 ft. of fill, foundation problems were paramount. A spread-footing plan was adopted whereby the basement walls and floor were reinforced and tied together to form a strong reinforced-concrete box over the whole building site. The four-story side wings (see photo) and one-story front wing may later be raised to ten-story height.

*QUEENSBOROUGH HALL, NEW YORK*—This steel frame, two and three-story, plus basement, building was started in March and completed in October. Walls are brick with stone trim, the entire design being based on utility of office space rather than ornate architecture. The cost of the building was limited to the amount which could be amortized from the equivalent of rentals previously paid for office space, less the cost of building maintenance. The structure, which contains 282,000 sq. ft. of floor space, cost about $2,000,000.

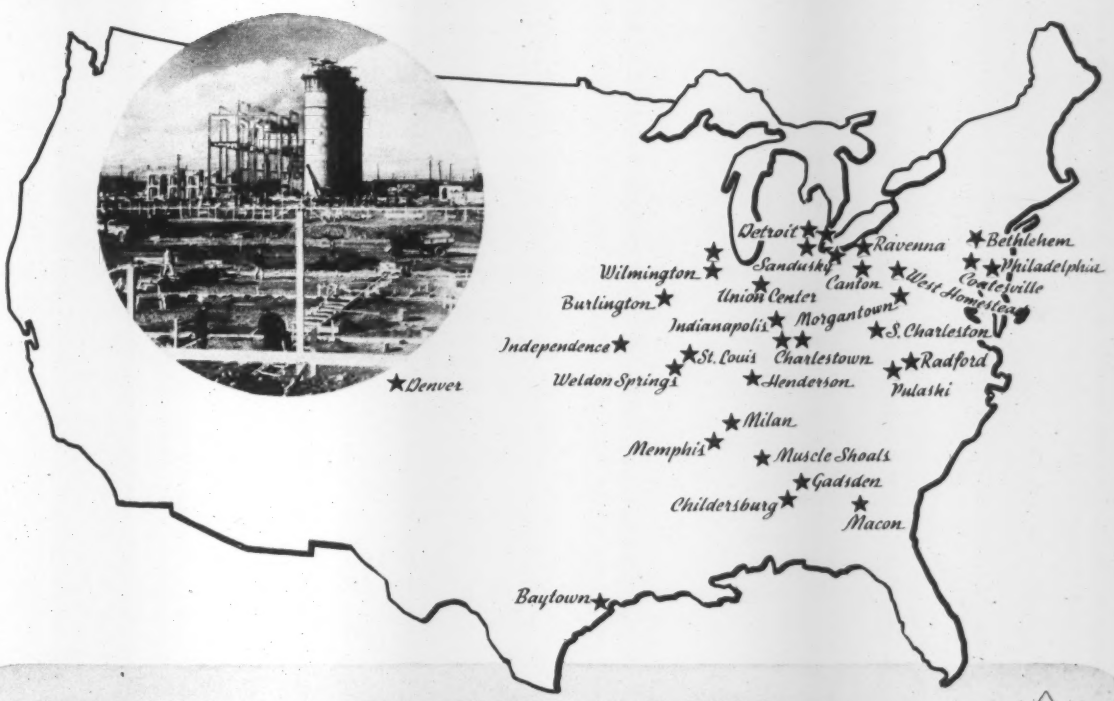
*PARKCHESTER HOUSING, NEW YORK*—A self-contained "city" planned by the Metropolitan Life Insurance Co. to house an estimated population of about 40,000 persons in 12,273 apartments was well on its way toward completion in the Bronx, New York City. Parkchester contains 51 fireproof apartment buildings, either of steel frame construction or of steel with wall-bearing construction. The buildings are of various heights up to 13 stories and average about 8 stories. A central heating plant, groups of stores, a theater, five ramp garages and other facilities are part of the community plan. The buildings cover some twenty-seven percent of the 130-acre site. At the end of the year, Metropolitan Life was giving consideration to new plans for housing in California.

*BANKERS LIFE BUILDING*—Early in 1940 the Bankers Life Company moved into its magnificent new home in Des Moines. This seven-story office building is notable for its 55-ft. clear span working areas, enameled steel sheet interior finish, radiation from pipes in the walls, ventilation through perforated metal ceilings and an exterior of granite and limestone.

*USHA HOUSING*—The U. S. Housing Authority has arranged with its local authorities for 511 housing projects costing $768,000,000 and providing 161,000 dwelling units. At the end of 1940, 344 of these, costing $549,000,000, were under construction, and 127 projects costing $220,000,000 had dwelling units available for occupancy. A total of 39,000 units were in service. Average unit cost of all dwellings in the program is $4,379. Exclusive of land, overhead, and non-dwelling facilities, the unit cost is $2,856. Nineteen of these projects are for defense housing, with a total cost of $24,000,000. Of these, 17 are under construction and two are open for occupancy. Cost of these projects is running lower—an average of $3,745. Status at the end of 1940 of some of the larger projects is as follows:

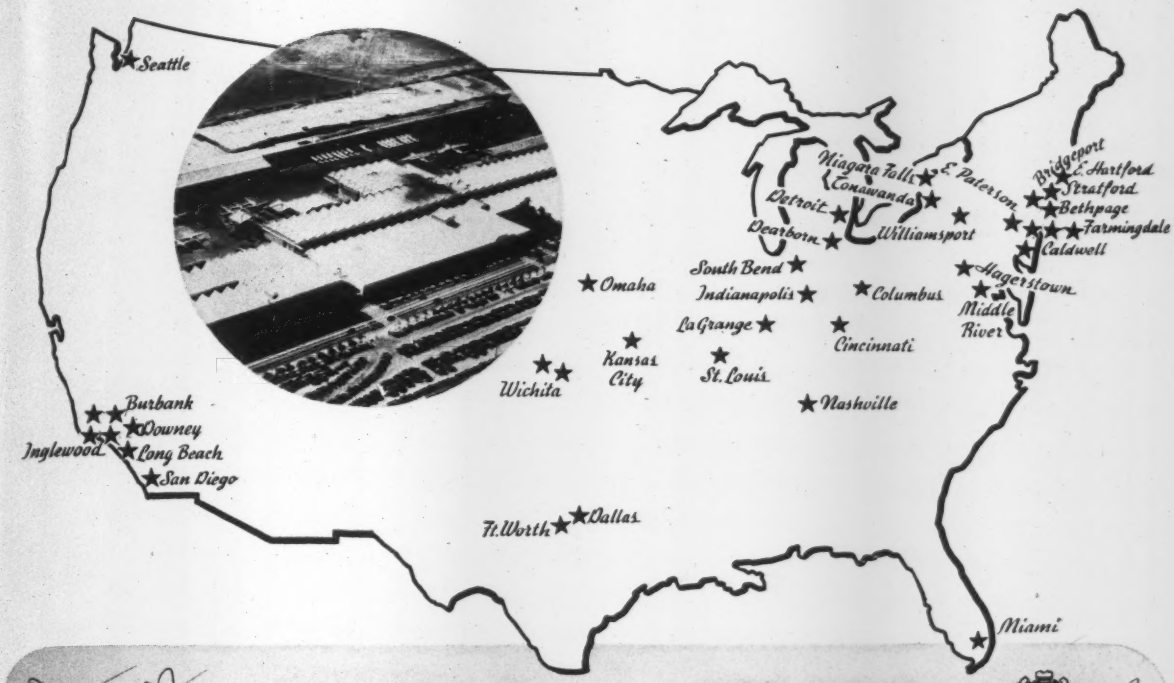
| Project Location | Total Cost, Thousands | Units | % Complete |
|---|---|---|---|
| Birmingham, Ala. | | | |
| Elyton Village | $4,007 | 860 | 100 |
| Central City | 4,138 | 913 | 75 |
| San Francisco | | | |
| Sunnydale | 2,714 | 772 | 87 |
| Bridgeport, Conn. | | | |
| Yellow Mill | 6,205 | 1,251 | 74 |
| Chicago | | | |
| Ida Wells Homes | 8,681 | 1,662 | 89 |
| Louisville, Ky. | | | |
| Clarksdale | 4,566 | 786 | 100 |
| Beecher Terrace | 4,518 | 808 | 87 |
| New Orleans | | | |
| St. Thomas St | 5,826 | 970 | 100 |
| Magnolia St | 4,213 | 723 | 100 |
| Iberville | 5,047 | 858 | 68 |
| Lafitte | 5,006 | 896 | 51 |
| Baltimore, Md. | | | |
| Perkins Homes | 4,400 | 688 | 5 |
| Boston | | | |
| Charlestown | 5,842 | 1,089 | 98 |
| South Boston | 5,022 | 873 | 88 |
| Mission Hill | 5,643 | 1,023 | 83 |
| Buffalo | | | |
| Commodore Perry | 4,414 | 772 | 100 |
| New York City | | | |
| Red Hook | 13,097 | 2,583 | 100 |
| Queensbridge | 15,393 | 3,161 | 100 |
| Vladeck | 8,611 | 1,531 | 100 |
| East River | 5,831 | 1,170 | 54 |
| Kingsboro | 5,499 | 1,166 | 6 |
| Syracuse, N. Y. | | | |
| Pioneer Homes | 4,550 | 678 | 100 |
| Philadelphia | | | |
| Tasker Street | 5,349 | 1,000 | 100 |
| Allen Homes | 7,421 | 1,324 | 2 |
| Pittsburgh | | | |
| Ter. Village 1 | 4,911 | 804 | 100 |
| Ter. Village 2 | 10,160 | 1,851 | 75 |
| Memphis, Tenn. | | | |
| Foote Homes | 4,462 | 900 | 100 |
| Detroit | | | |
| Herman Gardens | 11,108 | 2,150 | 6 |

*New England Mutual Life's future Boston home is rapidly nearing completion. The 200x340-ft. structure will make 7,000,000 cu.ft. of space available.*




# New Plants to Build AMMUNITION and ARMAMENT

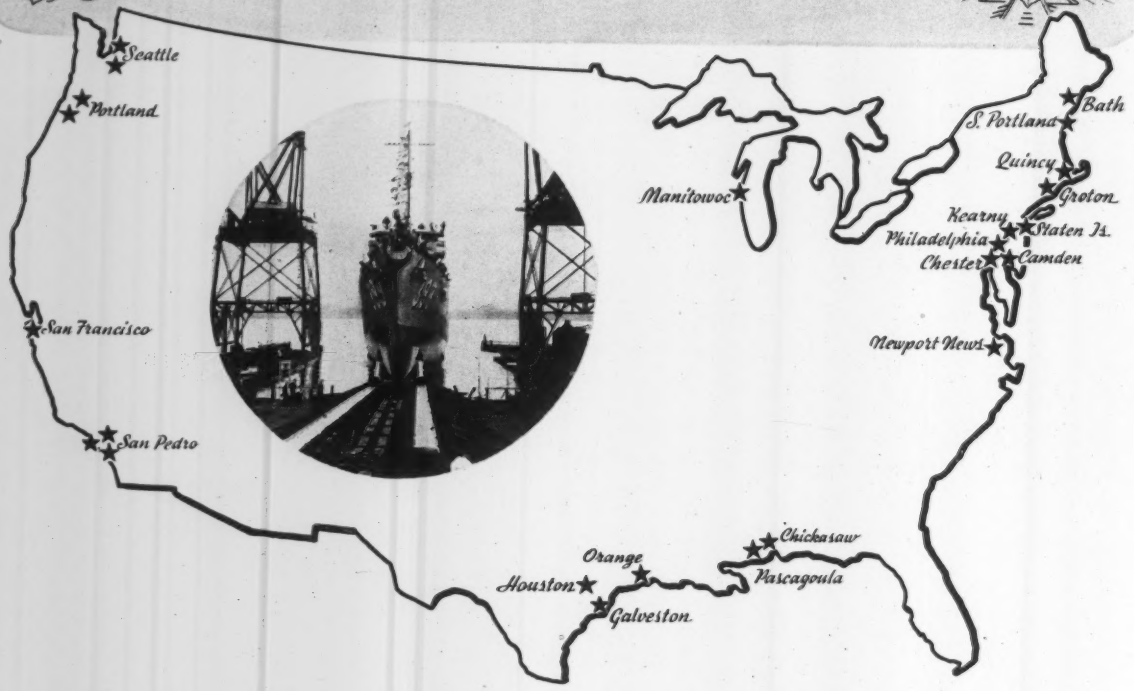
| LOCATION | TYPE OF PLANT | OPERATOR | CONTRACT | ENGINEERS | CONTRACTORS |
|---|---|---|---|---|---|
| Childersburg, Ala. | Powder & bcg loading | du Pont | $48,000,000 | du Pont | du Pont |
| Gadsden, Ala. | Shell forging | Lansdown Steel & Iron | 1,138,000 | | Rust Engr. |
| Muscle Shoals, Ala. | Syn. ammonia | Tenn. Valley Authority | 6,217,000 | | Stone & Webster |
| Denver, Colo. | Small arms & ammunition | Remington Arms | 10,000,000 | Smith, Hinchman & Grylls | Broderick & Gordon |
| Macon, Ga. | Ordnance | Reynolds Metals Co. | 1,673,315 | | |
| Wilmington, Ill. | TNT & DNT | du Pont | 30,937,000 | du Pont | Stone & Webster |
| Wilmington, Ill. | Shell loading | Sanderson & Porter | 14,500,000 | Sanderson & Porter | Sanderson & Porter |
| Charlestown, Ind. | Powder | du Pont | 74,000,000 | du Pont | du Pont |
| Charlestown, Ind. | Bag loading | Goodyear Engr. Corp. | 3,000,000 | Shreve, Anderson & Walker | Winston Bros., C. F. Haglin & Sons<br>Missouri Valley Bridge & Iron |
| Union Center, Ind. | Shell loading | Todd & Brown, Inc. | 11,500,000 | Giffels & Vallet, Inc., Chas. W. Cole & Son | Bates & Rogers |
| Indianapolis, Ind. | Bomb sights & fire control | Lukas-Harold Corp. | 6,000,000 | | Bids Feb. 1 |
| Burlington, Ia. | Shell loading | Day & Zimmerman | 9,900,000 | | A. Guthrie & Co., Al Johnson Constr. Co. |
| Henderson, Ky. | Anhy. ammonia | Solvay Process Co. | 11,132,440 | | |
| Detroit, Mich. | Tanks | Chrysler Corp. | 20,000,000 | Albert Kahn, Inc. | O. W. Burke Co. |
| Detroit, Mich. | Machine guns | A. C. Spark Plug | 20,000,000 | | Darin & Armstrong |
| Detroit, Mich. | Gun mounts, torpedo tubes | Hudson Motor Co. | 16,000,000 | Albert Kahn | |
| Weldon Springs, Mo | TNT | Atlas | 11,325,000 | Atlas | Fraser-Brace Co., Inc., R. N. McDowell |
| Independence, Mo. | Small arms ammunition | Remington Arms | 7,500,000 | Smith, Hinchman & Grylls | Foley Bros., Walbridge, Aldinger Co. |
| St. Louis, Mo. | Small arms ammuntion | Western Cartridge Co. | 11,819,000 | Giffels & Vallet, A. J. Brandt, Inc., Mauran, Russell, Crowell & Mullgardt | Fruin-Colnon Constr. Co., Fruco Constr. Co., Massman Constr Co. |
| Sandusky, Ohio | TNT & DNT | Trojan | 13,825,000 | | E. B. Badger & Sons |
| Ravenna, Ohio | Shell loading | Atlas | 14,200,000 | Wilbur Watson & Assoc. | Munkin-Conkey Constr. Co. |
| Canton, Ohio | Naval ordnance | Westinghouse Elect. Co. | 16,000,000 | | Rust Engr. Co. |
| Philadelphia, Pa. | Armor plate | Henry Disston & Sons. | 1,018,400 | I. S. Towsley | Barclay, White & Co. |
| Coatesville, Pa. | Armor plate | Lukens Steel Co. | 2,160,000 | | |
| West Homestead, Pa. | Gun tubes | Mesta Machine Co. | 1,680,000 | H. Meincke | |
| Bethlehem, Pa. | Naval ordnance | Bethlehem | 1,343,797 | | |
| Memphis, Tenn. | Powder for Eritain | Tenn. Powder Co. | 15,000,000 | du Pont | du Pont |
| Milan, Tenn. | Shell loading | Procter & Gamble | 14,000,000 | | H. K. Ferguson & Oman Constr. Co. |
| Baytown, Texas | Toluol | Humble Oil Co | 11,857,000 | | M. W. Kellogg Co., E. B. Badger & Sons Co., C. F. Braun & Co., The Austin Construction Co., S. W. Gaylord Constr. Co., |
| Radford, Va. | Powder | Hercules | 36,390,000 | Hercules | Mason & Hanger |
| Pulaski, Va. | Bag loading | Hercules | 9,376,390 | Hercules | Mason & Hanger |
| Morgantown, W. Va. | Ammonia | du Pont | 15,000,000 | du Pont | du Pont |
| S. Charleston, W. Va. | Ordnance | Carnegie-Illinois | 5,354,000 | | |




# New Plants to Build
# AIRPLANES–ENGINES–PROPELLERS

| LOCATION | OWNER OR OPERATOR | AMOUNT | ENGINEERS | CONTRACTOR |
|---|---|---|---|---|
| San Diego, Calif. | Consolidated Aircraft | $17,536,973 | Taylor & Taylor | Emil Brown & Co. |
| Inglewood, Calif. | Hughes Aircraft | 600,000 | H. L. Gogerty | MacIsaac & Menke |
| Long Beach, Calif. | Douglas Aircraft | 11,254,700 | Taylor & Taylor | P. S. Walker Co. |
| Downey, Calif. | Vultee Aircraft | 4,294,798 | | |
| Burbank, Calif. | Vega Airplane | 2,000,000 | | S. Simpson Constr. Co. |
| Burbank, Calif. | Lockheed Aircraft | 1,500,000 | Parkinson & Parkinson | F. B. Aldous & Son, H. W. Baum, MacIsaac & Menke, Alco Constr. Co. |
| Inglewood, Calif. | North American | 2,270,405 | | |
| East Hartford, Conn. | Pratt & Whitney | 15,559,000 | Albert Kahn | Turner Constr. Co., Robert G. Bent Co., Wadhams, May & Cary Co., Industrial Constr. Co. |
| Bridgeport, Conn. | Hamilton Propeller | 1,961,746 | Albert Kahn | Turner Constr. Co., Robert G. Bent Co., Iglehart, Caldwell & Scott, Inc. |
| Stratford, Conn. | Vought Sikorsky | 1,600,000 | Albert Kahn, C. W. Walker | Edwin Moss & Son |
| Miami, Fla. | Intercontinent Aircraft | 750,000 | Weed & Reeder | M. R. Harrison Constr. |
| La Grange., Ill. | Buick | 24,313,150 | | |
| Indianapolis, Ind. | Allison Engine | 6,500,000 | Austin Co. | Austin Co., Gen. Concrete Fire Proofing Co. |
| South Bend, Ind. | Studebaker | 20,000,000 | Giffels & Vallet | |
| Wichita, Kans. | Boeing (Stearman Div.) | 3,367,943 | Austin Co., Overend & Boucher | Austin Co., Walter Armagost |
| Wichita, Kans. | Beech Aircraft | 1,619,509 | Overend & Boucher | Armagost & Son, Armagost & Moreland, O. W. Armagost |
| Hagerstown, Md. | Fairchild | 982,891 | | |
| Middle River, Md. | Glenn L. Martin | 1,000,000 | Owner | Owner; Consol. Engr. Co. |
| Dearborn, Mich. | Ford | 21,965,420 | Giffels & Vallet | American Bridge Co., Bryant & Detwiler, Julius Porath & Son, Esslinger-Misch Co. |
| Detroit, Mich. | Packard | 16,250,000 | | Handyside Constr. Co., O. W. Burke Co. |
| Kansas City, Mo. | North American | 8,000,000 | | |
| St. Louis, Mo. | Curtiss-Wright | 6,000,000 | Albert Kahn | H. B. Deal & Co. |
| Omaha, Neb. | Glenn L. Martin | 10,000,000 | Albert Kahn | |
| Caldwell, N. J. | Curtiss Propeller | 3,500,000 | Albert Kahn | |
| E. Paterson, N. J. | Wright Aeronautical | 1,500,000 | | |
| Farmingdale, N. Y. | Republic Aviation | 5,210,513 | Albert Kahn | Turner Constr. Co. |
| Bethpage, N. Y. | Grumman Aircraft | 3,500,000 | Austin Co. | Austin Co. |
| Niagara Falls, N. Y. | Bell Aircraft | 1,023,200 | Austin Co. | Austin Co. |
| Farmingdale, N. Y. | Liberty Aircraft | 1,088,000 | Brown & Matthews | Brown & Matthews |
| Tonawanda, N. Y. | Curtiss-Wright | 8,000,000 | Albert Kahn | John W. Cowper Co., Darin & Armstrong |
| Farmingdale, N. Y. | Fairchild (Ranger Div.) | 1,478,800 | | |
| Cincinnati, Ohio | Wright Aeronautical | 37,000,000 | Albert Kahn | Frank Messer & Sons |
| Columbus, Ohio | Curtiss-Wright Corp. | 10,000,000 | Albert Kahn | Darin & Armstrong |
| Williamsport, Pa. | Lycoming | 1,597,491 | Austin Co. | Austin Co. |
| Nashville, Tenn. | Vultee (Stinson div.) | 2,000,000 | Marr & Holman | Ford J. Twaits Co. |
| Dallas, Tex. | North American | 1,129,000 | Allen & Kelly | James Stewart & Co. |
| Fort Worth, Tex. | Consol. Aircraft | 4,000,000 | U. S. Engineers | |
| Seattle, Wash. | Boeing Aircraft Co. | 7,368,849 | Austin Co. | Austin Co. |

# SHIPWAYS–SHIPYARDS

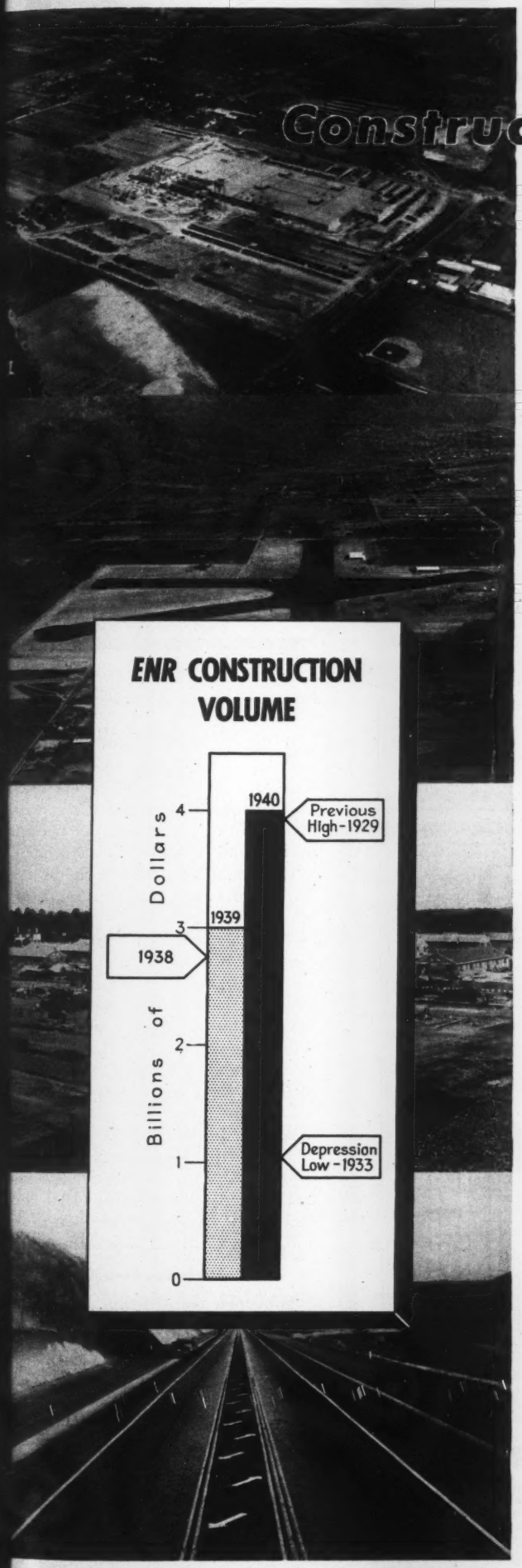



| LOCATION | OPERATOR | CONTRACTS | ENGINEERS | CONSTRUCTION CONTRACTOR |
|---|---|---|---|---|
| Chickasaw, Ala. | Gulf Shipbldg. | $2,500,000 | | |
| San Francisco, Calif. | Bethlehem Steel | 12,662,000 | | MacDonald & Kahn, Ltd. |
| San Pedro, Calif. | Bethlehem Steel | 4,006,000 | | |
| San Pedro, Calif. | Calif. Shipbldg. | 4,766,000 | | Bechtel-McCone-Parsons |
| San Pedro, Calif. | Los Angeles Shipbldg & Drydock Co. | 850,000 | W. A. Sandberg Holmes & Narver | Case Constr. Co. |
| Groton, Conn. | Electric Boat | 4,600,000 | | Mondelci & Benvenuti, Merritt, Chapman & Scott |
| S. Portland, Me. | Todd Shipyards | 1,500,000 | Chas. T. Main | Sanders Engrg. Co. |
| Bath, Me. | Bath Iron Works | 2,400,000 | | |
| Quincy, Mass. | Bethlehem Steel | 14,227,500 | Fay, Spofford & Thorndike | Tredennick Billings Co., B. R. Switzer Co., Inc. |
| Pascagoula, Miss. | Ingalls Shipbldg | 2,000,000 | | |
| Camden, N. J. | New York Shipbldg. | 10,500,000 | | |
| Kearny, N. J. | Federal Shipbldg. | 7,750,000 | | |
| Staten Island, N. Y. | Bethlehem Steel | 3,406,000 | Lockwood Greene | |
| Portland, Ore. | Willamette Ir. & St. | 1,000,000 | | Willamette Iron & Steel |
| Portland, Ore. | Portland Shipbldg. | 4,787,000 | | Portland Shipbldg. Co.* |
| Chester, Pa. | Sun Shipbldg. | 2,500,000 | | |
| Philadelphia, Pa. | Cramp Shipbldg. | 10-12,000,000 | Carson & Carson | C. F. Rohleder |
| Houston, Tex. | Houston Shipbldg. | 4,680,000 | | |
| Galveston, Tex. | Todd-Galveston Drydock | 2,254,342 | Fred'k R. Harris | |
| Orange, Tex. | Consolidated Steel | 4,600,000 | S. Jelinek | Bechtel-McCone-Parsons |
| Newport News, Va. | Newport News Shipbldg. | 14,000,000 | | |
| Seattle, Wash. | Seattle-Tacoma Shipbldg. | 8,000,000 | | General Constr. Co. |
| Seattle, Wash. | Associated Shipbldgrs. | 700,000 | | Puget Sound Br. & Dredging |
| Manitowoc, Wis. | Manitowoc Shipbldg. Corp. | 1,000,000 | | American Bridge Co. |

*Composed of Gilpin Constr. Co., Morrison-Knudsen Co., Henry J. Kaiser Co., W. A. Bechtel Co., Utah Constr. Co., MacDonald & Kahn, Pacific Bridge Co., Todd Shipyards, J. F. Shea Co. (General Constr. Co. does preliminary work at site)

# BUILDING A MUNITIONS INDUSTRY

**The three maps with supporting tables presented here picture the location of great construction activity in the nation's program of developing a munitions industry. Only the larger units of new plant are represented; factories manufacturing parts or tools are not shown; and in general only those units which are owned or financed by the federal government are included. A complete picture of America's capacity to produce munitions of war would, of course, contain several thousand plants instead of the hundred or so shown. And on these other plants, too, construction is actively under way. It all adds up to the biggest building program in history.**




# Construction Records and Direction Signs

***Engineering construction shattered all existing records in 1940 and piled up its seventh consecutive year of gains. New highs in public and industrial buildings, highways and unclassified construction were established. The third successive record-breaking public volume and a 10-year high in private work set the stage for 1940's record. The following pages report 1940 construction progress and the outlook for 1941.***


**CONSTRUCTION VOLUME**

**CONSTRUCTION FINANCING**

**ENR CONSTRUCTION TOTAL**

**RESIDENTIAL BUILDING SUMMARY**

**CONSTRUCTION EMPLOYMENT**

**CONSTRUCTION MATERIAL SHIPMENTS**

**CONSTRUCTION COSTS**

**CONSTRUCTION WAGE RATES**

**CONSTRUCTION MATERIAL PRICES**


*Photos by courtesy of Fairchild Aerial Surveys, Inc., Air Corps, Maxwell Field, Ala., ENR Staff*

# The Review and the Outlook

THE CONSTRUCTION MARCH of 1940 came in like a lamb and went out like a lion. At the end of June, volume lagged 11 percent behind 1939, but by the end of December 1940 had established a 22 percent gain. The estimated total for 1940 is $8,510,000,000, the highest since 1929, and the seventh year in a row to top the preceding year. Defense construction produced this speed-up.

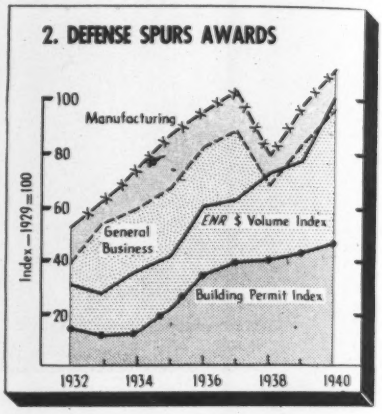
Manufacturing and general business, too, show the effect of defense spending. The *Federal Reserve Board* index of manufacturing climbed to an all-time high, 12 percent above 1929, and 14 percent over 1939. The *Business Week* index of general business topped last year by 16 percent, and reached the second highest peak on record, exceeded only by 1929.

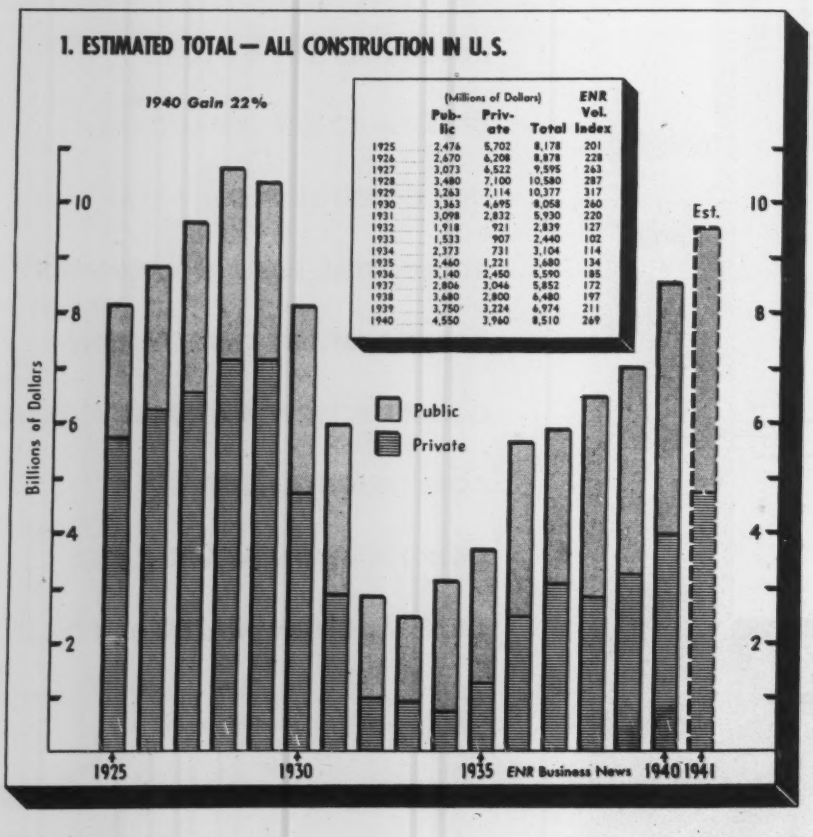
Both of these indexes doubled their low levels of 1932, manufacturing gaining 116 percent, and general business, 104 percent. The construction dollar volume index topped 1932 by 228 percent, and exceeded the low record set in 1933 by 274 percent.

The 8.5 billion dollar construction total was made possible by the third consecutive record-breaking public volume, $4,550,000,000, and the largest amount of private engineering and residential building since 1930, $3,960,000,000. Federal awards reached a new peak, $2,300,000,000, due to the heavy volume of military and naval awards, and were 168 percent higher than in 1939. State and municipal construction, which was primarily responsible for the public record in 1939, fell 22 percent below last year to $2,250,000,000.

Total private construction in 1940 was 23 percent over 1939. Private engineering awards, the highest since 1929, were up 31 percent, aided materially by the highest industrial building volume in history; and the residential building reached a new peak since 1929, gaining 15 percent over a year ago.

The *ENR* Construction Volume Index (1913 = 100), the measure of construction dollar volume adjusted for cost changes, rose to 269 for 1940, a 27 percent jump over 1939. The yearly values of the index as well as totals of public and private construction estimates since 1925 are shown in Chart 1.




Building permits reported by three separate sources all recorded substantial gains for 1940 over 1939. The amount of increase varies with the authority reporting: 9.8 percent by Dun and Bradstreet for 215 cities, a 10-year high; 22.5 percent by the Bureau of Labor Statistics for 2,089 cities having populations over 1,000, and 13.1 percent by *Commercial and Financial Chronicle* for 354 cities, also the highest in a decade. All sections of the country except Middle Atlantic and the West Central states showed gains over 1939, according to Dun and Bradstreet. These two sections were, respectively, 3.8 and 3.7 percent lower. The greatest gain took place in the South Atlantic area, 22.6 percent. Mountain states were next, up 21.9 percent; then East Central, 20.7 percent; Pacific, 18.0 percent; New England, 14.0 percent; and South Central, 3.0 percent.

### Construction financing

More new construction money was made available to the industry in 1940 than in any year in the preceding decade. The new financing volume, $3,895,000,000, topped 1939 by 62 percent. Federal financing, $2,281,961,000, largely for defense work, made up the bulk of the new

capital total, and was more than double last year. Private investment, $972,000,000, gained 24 percent over a year ago. Cost of financing for all types of bonds was below 1939.

Construction and building costs averaged a 2.7 percent increase over 1939. Labor rates, both skilled and common, topped the 1939 average by 2 percent. The year-end lumber price component of the cost index was 15 percent higher than at the outset of the year. Cement and steel prices remained unchanged from a year ago.

### The outlook for 1941

The continuation of the fast pace of the last half of 1940 is expected to be maintained throughout the current year. The President's budget message contained recommendations for $1,164,000,000 in new construction in the United States for the fiscal year 1942, but made no provision for construction funds for the British-aid program. The War Department, it is learned, will ask Congress for $700,000,000 to build stand-by munition plants to produce for Great Britain; and the naval expansion bill just passed by the House contains $315,000,000 for private shipyard expansion, and $194,000,000 for doubling naval ordnance manufacturing facilities.

Continued construction of housing facilities to shelter civilian and military workers in defense industries is also anticipated during 1941. If the plan is adopted whereby the army's manpower is increased to 2,000,000 men, additional army training centers must be built.

On the private side of the picture, a $282,000,000 program of steel plant expansion is proposed, and a further participation of private capital in the dwelling field is expected.

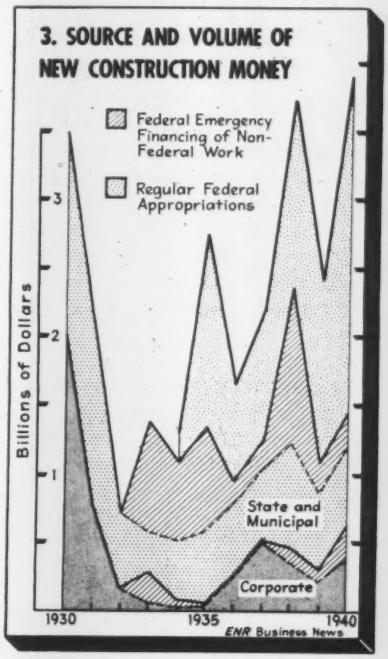
All of the above factors combine to make the prospects for 1941 bright indeed. *Engineering News-Record* forecasts an overall construction gain of 11 percent over 1940; and anticipates that major increases will be felt in public and industrial buildings, shipbuilding facilities, and airport construction. Minor gains are expected in streets and roads, bridges, and commercial building.

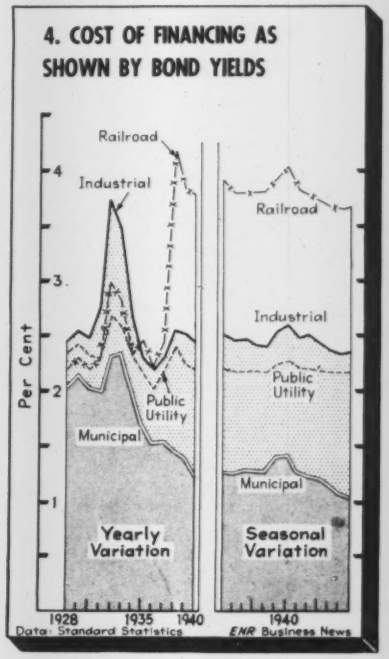
Construction costs begin the year with small increases in lumber prices, but with all other components of the *ENR* Construction Cost Index at December levels.

The results of the exchange of views, between the National Defense Commission and the manufacturers regarding lumber prices may have an important bearing on price structures during the emergency period.

In the various sections which follow is a detailed report on construction financing, engineering construction, residential building, employment in the industry, material shipments, cost trends, and wage rates for construction.

## Construction Financing




CONSTRUCTION FINANCING in 1940 reached the highest total in the last decade and topped 1939 by 62 percent. Federal appropriations were primarily responsible for the high volume, doubling the 1939 figure. Corporate construction money received through bond issues and through borrowing from governmental agencies gained 105 percent over last year. State and municipal financing, both through bond sales and government loans, increased 3 percent. Federal-aid for highways, $191,000,000, which must be matched by state funds, was unchanged.

Cost of construction money fell below 1939 for treasury, municipal, industrial, public utility and railroad bonds. Yields of high-grade municipal bonds dropped 9 percent under the average for 1939, to a new all-time low. Treasury bond yields, also at unprecedented low levels, were 6 percent below 1939. Industrial bond yields decreased 3 percent; public utilities, 2 percent; railroad bonds, 1 percent.

The 1940 annual average yields for the various types of high-grade bonds in percent are: treasury, 2.21; municipal, 2.50; industrial, 4.88; public utility, 4.37; and railroad, 7.57.

### II—NEW CONSTRUCTION CAPITAL

(Millions of Dollars)

| | Corporate | State and Municipal | Federal | Total |
|---|---|---|---|---|
| 1925 | $1,966 | $1,352 | ..... | $3,318 |
| 1926 | 1,824 | 1,344 | ..... | 3,168 |
| 1927 | 1,784 | 1,475 | ..... | 3,259 |
| 1928 | 1,568 | 1,379 | ..... | 2,947 |
| 1929 | 1,758 | 1,418 | ..... | 3,176 |
| 1930 | 2,032 | 1,434 | ..... | 3,466 |
| 1931 | 787 | 1,235 | ..... | 2,022 |
| 1932 | 159 | 561 | ..... | 720 |
| 1933 | 292 | 1,091‡ | ..... | 1,383 |
| 1934 | 77† | 1,011‡ | 194 | 1,282 |
| 1935 | 47† | 1,337‡ | 1,354 | 2,738 |
| 1936 | 251 | 698‡ | 691 | 1,640 |
| 1937 | 518† | 738‡ | 946 | 2,202 |
| 1938 | 457† | 1,902‡ | 1,345 | 3,704 |
| 1939 | 304† | 783‡ | 1,318 | 2,405 |
| 1940 | 624† | 805‡ | 2,466 | 3,895 |

Note:— Federal appropriations include federal-aid highway, WPA, and regular departmental appropriations for construction.

† Includes $237,000,000 RFC and PWA loans, '33; $55,000,000, '34; $9,000,000, '35; $807,000, '37; $76,106,000 REA, $4,500,000 RFC loans, '38; $89,000,000 REA and $400,000 RFC loans, '39; $40,000,000 REA and $193,000,000 in RFC loans, '40.

‡ Includes $814,000,000 RFC and PWA loans and grants, '33; $580,000,000, '34; $808,000,000, '35; $164,700,000, '36; $207,000,000, '37; $723,265,000 PWA, $99,844,000 RFC, $320,986,000 USHA loans, '38; $216,000,000 in USHA loans, '39; $219,000,000 USHA, $5,000,000 RFC loans in '40.

# *ENR* Construction Highest in History

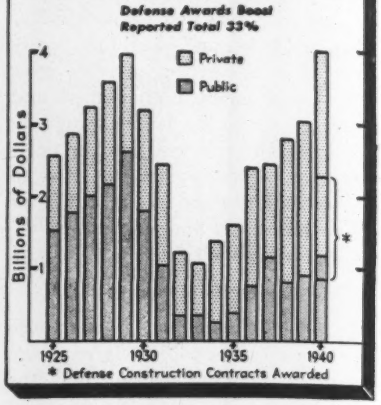
THE 1940 *ENR* engineering construction volume reached the highest level ever recorded. The total, $3,987,243,000, topped the previous high of $3,950,000,000 in 1929 by 1 percent, and the 1939 award figure by 33 percent. *ENR* statistics include all types of engineering construction in continental United States above the minimums shown at the head of Table III.

The combination of the highest public total ever reported, $2,824,989,000, and the highest private volume since 1930, $1,162,254,000, was responsible for the record engineering awards. The tremendous volume of federal work, primarily for defense construction, $1,451,726,000, set a new mark, while state and municipal volume, $1,373,263,000, the other factor in public work, dropped 22 percent below a year ago.

Defense construction spending, both that directly awarded by government contracts and that necessitated by expansion of privately-owned industries important to defense, accounted for $1,393,600,000, or 35 percent of the year's volume. Over four-fifths of the defense total was spent on publicly owned projects, principally cantonments, barracks, government-owned manufacturing facilities, airbases, airports, shipyards and shipways, etc. The remaining fifth, was for expansion of privately-owned strategic war industries.

In a year of record-breaking activity in the construction field, new marks were established in four classes of work. Public building awards reached $1,196,257,000, a total that

5. RECORD *ENR* CONSTRUCTION



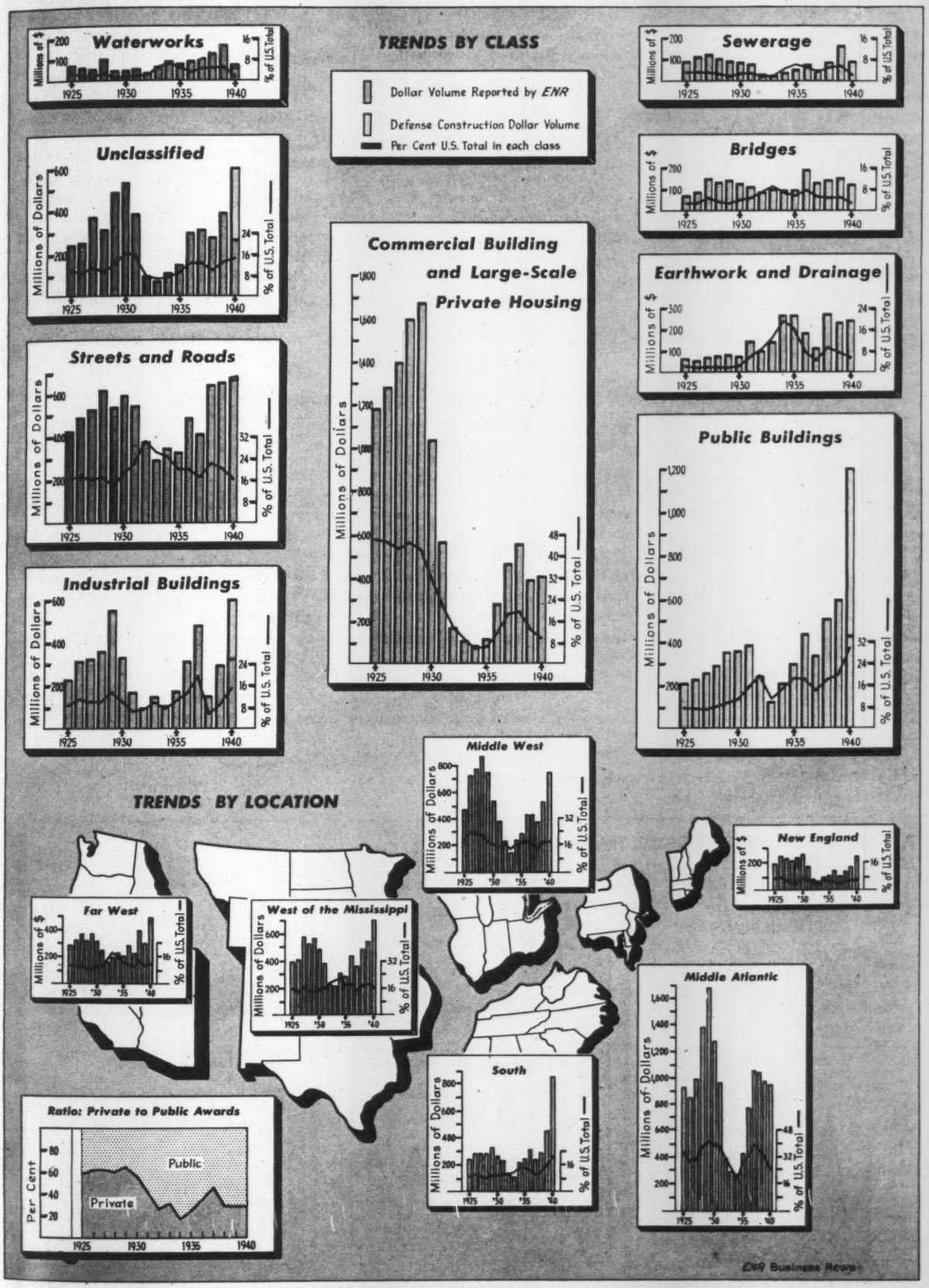

## III—ENGINEERING CONSTRUCTION REPORTED IN 1940 BY *ENR*

(Thousands of Dollars)

Minimum contracts reported: Water works, excavation, drainage and irrigation, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

| States | Water-works | Sewers | Bridges | Earth-work | Streets and Roads | BUILDINGS Indus-trial | BUILDINGS Com-mercial | BUILDINGS Public | Un-classified | Federal Gov't Work | All Construction Private | All Construction Public | 1940 Total | 1939 Total | % Gain '39 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Me | 127 | 27 | 213 | 34 | 1,204 | 490 | ..... | 3,398 | 9,327 | 9,976 | 924 | 13,896 | 14,820 | 6,320 | 135 |
| N. H | 284 | ..... | 110 | 536 | 1,626 | 488 | 1,360 | 2,214 | 2,096 | 2,700 | 3,146 | 5,568 | 8,714 | 11,000 | −21 |
| Vt | ..... | 80 | 215 | ..... | 1,567 | 240 | 300 | 1,904 | 341 | 984 | 881 | 3,766 | 4,647 | 4,305 | 7 |
| Mass | 2,263 | 1,142 | 1,470 | 1,861 | 10,402 | 13,636 | 17,086 | 27,311 | 23,564 | 43,399 | 32,160 | 66,575 | 98,735 | 73,374 | 35 |
| R. I | 8 | 1,020 | 185 | 613 | 1,314 | 750 | 774 | 9,296 | 26,763 | 32,332 | 1,641 | 39,082 | 40,723 | 13,710 | 196 |
| Conn | 1,282 | 2,827 | 4,603 | 5,226 | 7,112 | 19,110 | 15,902 | 17,091 | 3,186 | 12,399 | 35,862 | 40,477 | 76,339 | 66,270 | 15 |
| **New Eng.** | **3,964** | **5,096** | **6,796** | **8,270** | **23,225** | **34,714** | **35,422** | **61,214** | **65,277** | **101,790** | **74,614** | **169,364** | **243,978** | **174,979** | **39** |
| N. Y | 5,757 | 16,431 | 37,748 | 10,707 | 54,579 | 47,922 | 115,303 | 60,331 | 44,056 | 34,479 | 180,189 | 212,645 | 392,834 | 521,663 | −25 |
| N. J | 3,223 | 8,232 | 2,775 | 7,895 | 35,424 | 24,840 | 23,380 | 36,155 | 34,003 | 49,053 | 53,814 | 122,113 | 175,927 | 170,291 | 3 |
| Pa | 4,787 | 5,726 | 7,376 | 8,207 | 61,890 | 40,838 | 41,297 | 79,804 | 30,046 | 82,651 | 93,824 | 186,147 | 279,971 | 182,317 | 53 |
| Md | 305 | 447 | 2,910 | 863 | 6,048 | 9,019 | 5,071 | 35,548 | 1,849 | 29,391 | 14,997 | 47,063 | 62,060 | 36,471 | 72 |
| D. C | 240 | 55 | 220 | 509 | 905 | ..... | 5,250 | 22,255 | 3,897 | 21,212 | 6,050 | 27,281 | 33,331 | 56,064 | −40 |
| Del | ..... | 112 | 1,526 | 422 | 1,127 | 345 | 3,150 | 572 | 122 | 2,442 | 3,617 | 3,759 | 7,376 | 11,596 | −36 |
| **Mid. Atl.** | **14,312** | **31,003** | **52,555** | **28,603** | **159,973** | **122,964** | **193,451** | **234,665** | **113,973** | **219,228** | **352,491** | **599,008** | **951,499** | **978,402** | **−3** |
| Va | 784 | 19 | 2,134 | 364 | 7,429 | 19,095 | 3,365 | 83,362 | 51,123 | 119,293 | 32,811 | 134,864 | 167,675 | 33,916 | 395 |
| W. Va | ..... | 95 | 587 | 894 | 4,641 | 2,002 | 184 | 21,830 | 305 | 22,051 | 2,491 | 28,047 | 30,538 | 27,123 | 13 |
| N. C | 2,353 | 762 | 2,070 | 926 | 17,478 | 3,361 | 3,463 | 16,139 | 18,297 | 14,943 | 22,223 | 42,626 | 64,849 | 67,434 | −4 |
| S. C | 632 | 190 | 735 | 4,140 | 4,834 | 760 | 1,850 | 31,662 | 1,559 | 29,870 | 3,995 | 42,367 | 46,362 | 40,907 | 13 |
| Ga | 1,159 | 1,042 | 2,036 | 1,489 | 10,402 | 12,320 | 2,719 | 34,120 | 4,274 | 21,035 | 17,484 | 52,077 | 69,561 | 41,679 | 67 |
| Fla | 2,148 | 1,722 | 1,967 | 3,166 | 22,800 | 8,019 | 29,786 | 29,548 | 49,678 | 62,735 | 40,805 | 108,029 | 148,834 | 58,719 | 154 |
| Ala | 872 | 162 | 543 | 211 | 8,833 | 16,674 | 598 | 27,032 | 13,577 | 31,823 | 18,435 | 50,067 | 68,502 | 36,940 | 86 |
| Miss | 284 | 297 | 894 | 6,214 | 13,541 | 3,865 | 308 | 14,282 | 4,428 | 20,333 | 5,450 | 38,663 | 44,113 | 34,691 | 27 |
| La | 321 | 327 | 1,842 | 4,996 | 4,206 | 8,493 | 1,900 | 28,069 | 3,146 | 23,597 | 13,187 | 40,113 | 53,300 | 40,865 | 30 |
| Ky | 254 | 1,351 | 86 | 621 | 10,470 | 5,298 | 750 | 18,440 | 1,800 | 17,872 | 7,375 | 31,695 | 39,070 | 40,336 | −3 |
| Tenn | 401 | 50 | 613 | 44,824 | 12,810 | 22,675 | 3,679 | 30,660 | 4,738 | 69,121 | 29,037 | 91,413 | 120,450 | 31,646 | 293 |
| **South.** | **9,208** | **6,017** | **13,507** | **67,845** | **117,444** | **102,562** | **48,602** | **335,144** | **152,925** | **432,673** | **193,293** | **659,961** | **853,254** | **454,256** | **88** |
| Ohio | 6,147 | 7,692 | 2,950 | 2,321 | 57,536 | 71,520 | 18,224 | 39,774 | 11,362 | 24,320 | 96,213 | 121,313 | 217,526 | 167,475 | 30 |
| Ind | 258 | 4,820 | 1,939 | 9,017 | 27,825 | 14,595 | 4,515 | 76,345 | 7,055 | 72,715 | 22,877 | 123,492 | 146,369 | 75,352 | 94 |
| Ill | 3,808 | 7,094 | 7,508 | 7,129 | 33,364 | 38,627 | 26,145 | 74,896 | 11,733 | 73,558 | 68,002 | 142,302 | 210,304 | 190,438 | 10 |
| Wis | 1,088 | 3,371 | 976 | 2,347 | 6,111 | 16,051 | 3,323 | 2,483 | 13,483 | 1,474 | 20,964 | 28,269 | 49,233 | 48,134 | 2 |
| Mich | 3,212 | 893 | 3,173 | 853 | 22,836 | 37,784 | 6,694 | 40,498 | 3,567 | 28,284 | 45,830 | 73,680 | 119,510 | 55,027 | 127 |
| **Mid. West** | **14,513** | **23,870** | **16,546** | **21,667** | **147,672** | **178,577** | **58,901** | **233,996** | **47,200** | **200,351** | **253,886** | **489,056** | **742,942** | **536,426** | **38** |
| Minn | 244 | 1,309 | 886 | 18 | 8,562 | 5,964 | 5,343 | 4,024 | 7,466 | 2,682 | 16,521 | 17,295 | 33,816 | 50,520 | −33 |
| Iowa | 1,468 | 1,303 | 2,411 | 1,077 | 12,416 | 4,003 | 3,035 | 21,622 | 7,879 | 20,392 | 13,785 | 41,429 | 55,214 | 57,205 | −3 |
| Mo | 1,109 | 3,881 | 3,310 | 5,592 | 14,866 | 17,495 | 8,430 | 36,373 | 9,136 | 40,394 | 31,323 | 68,869 | 100,192 | 61,878 | 46 |
| Ark | 105 | 559 | 710 | 2,787 | 10,800 | 80 | 950 | 5,631 | 2,669 | 8,553 | 2,298 | 21,993 | 24,291 | 16,343 | 49 |
| N. D | 132 | 25 | 51 | 1,569 | 4,839 | 868 | ..... | 56 | 1,586 | 1,620 | 2,274 | 6,852 | 9,126 | 9,841 | −7 |
| S. D | 53 | 116 | 235 | 237 | 3,973 | 375 | ..... | 732 | 1,375 | 600 | 1,552 | 5,544 | 7,096 | 9,788 | −28 |
| Neb | 1,120 | 1,795 | 333 | 3,725 | 13,361 | 1,944 | 428 | 2,510 | 6,923 | 3,706 | 7,013 | 25,126 | 32,139 | 42,683 | −25 |
| Kan | 2,539 | 153 | 1,369 | 8,464 | 10,592 | 4,416 | 150 | 5,329 | 3,974 | 12,969 | 7,388 | 29,598 | 36,986 | 22,926 | 61 |
| Okla | 861 | 407 | 2,521 | 5,426 | 13,111 | 4,669 | 150 | 4,108 | 4,169 | 8,630 | 6,371 | 29,051 | 35,422 | 42,788 | −17 |
| Tex | 6,098 | 6,366 | 4,926 | 23,847 | 65,002 | 46,989 | 9,023 | 80,341 | 50,050 | 110,178 | 66,282 | 226,360 | 292,642 | 168,206 | 74 |
| Mont | 160 | 784 | 614 | 1,199 | 7,593 | 120 | 425 | 2,616 | 5,782 | 1,524 | 4,524 | 14,769 | 19,293 | 19,221 | ..... |
| Wyo | 441 | 89 | 540 | 479 | 4,378 | 220 | ..... | 2,268 | 565 | 4,236 | 651 | 8,329 | 8,980 | 12,337 | −27 |
| Colo | 1,052 | 259 | 688 | 10,468 | 6,087 | 1,704 | 450 | 4,939 | 9,709 | 16,739 | 6,944 | 28,412 | 35,356 | 25,349 | 40 |
| N. M | ..... | 221 | 20 | 3,470 | 5,199 | 635 | ..... | 1,508 | 616 | 2,695 | 897 | 10,772 | 11,669 | 9,527 | 21 |
| **W. of Miss.** | **15,382** | **17,267** | **18,614** | **68,358** | **180,779** | **89,482** | **28,384** | **172,057** | **111,899** | **234,918** | **167,823** | **534,399** | **702,222** | **548,612** | **28** |
| Idaho | 35 | 799 | ..... | 757 | 2,879 | 260 | 506 | 369 | 1,563 | 1,324 | 2,136 | 5,032 | 7,168 | 6,072 | 18 |
| Utah | 685 | 1,074 | 88 | 1,066 | 4,516 | 871 | 500 | 7,018 | 3,155 | 10,092 | 2,404 | 16,569 | 18,973 | 13,930 | 36 |
| Ariz | 178 | 72 | 237 | 1,446 | 3,520 | 15,040 | 1,200 | 3,186 | 1,211 | 4,899 | 16,546 | 9,544 | 26,090 | 13,201 | 98 |
| Nev | ..... | ..... | ..... | 318 | 2,319 | 675 | 558 | 2,636 | 295 | 3,008 | 1,528 | 5,273 | 6,801 | 6,351 | 7 |
| Wash | 2,549 | 1,628 | 1,870 | 10,848 | 9,616 | 20,115 | 1,258 | 34,793 | 13,134 | 44,620 | 24,597 | 71,214 | 95,811 | 77,251 | 24 |
| Ore | 258 | 424 | 400 | 7,097 | 7,408 | 536 | 1,150 | 7,238 | 5,691 | 22,149 | 2,589 | 27,613 | 30,202 | 27,695 | 9 |
| Calif | 8,620 | 4,217 | 9,538 | 18,010 | 18,821 | 28,268 | 30,239 | 103,941 | 86,649 | 176,674 | 70,347 | 237,956 | 308,303 | 165,681 | 86 |
| **Far West** | **12,325** | **8,214** | **12,133** | **39,542** | **49,079** | **65,765** | **35,411** | **159,181** | **111,698** | **262,766** | **120,147** | **373,201** | **493,348** | **310,181** | **59** |
| **U. S. 1940** | **69,704** | **91,467** | **120,151** | **234,285** | **678,172** | **594,064** | **400,171** | **1,196,257** | **602,972** | **1,451,726** | **1,162,254** | **2,824,988** | **3,987,243** | ..... | ..... |
| U. S. 1939 | 162,921 | 159,822 | 150,631 | 232,590 | 643,771 | 282,980 | 387,779 | 592,056 | 389,856 | 353,310 | 890,707 | 2,112,149 | ..... | 3,002,856 | ..... |
| % Gain '40/'39 | −57 | −43 | −20 | 1 | 5 | 110 | 3 | 102 | 54 | 311 | 31 | 34 | ..... | ..... | 33 |
| **Canada '40** | **2,880** | **2,163** | **3,734** | **2,684** | **17,930** | **64,676** | **15,980** | **67,186** | **75,386** | ..... | **90,026** | **162,593** | **252,619** | ..... | ..... |
| **Canada '39** | **6,954** | **2,230** | **3,033** | **6,555** | **33,647** | **20,994** | **12,089** | **10,049** | **17,505** | ..... | **39,134** | **73,922** | ..... | **113,056** | **124** |

## 6. CLASSES AND LOCATION OF CONSTRUCTION REPORTED BY *ENR*



topped the previous high of 1939 by 102 percent. Industrial building volume, $594,064,000, topped the 1929 record by 8 percent, and rose 110 percent over last year. Street and road lettings, $678,172,000, eclipsed the mark of a year ago; and unclassified construction, $602,972,000, which encompasses airport, airbase and shipbuilding construction so prevalent in 1940, exceeded the 1930 high by 14 percent, and gained 54 percent over last year.

Almost two-thirds of the record public building volume, $773,845,000, was for construction of defense projects. Government-owned manufacturing plants made up $326,184,000, or 42 percent of the defense total, and army training centers, barracks and civilian and military housing accounted for most of the balance.

### Industrial buildings

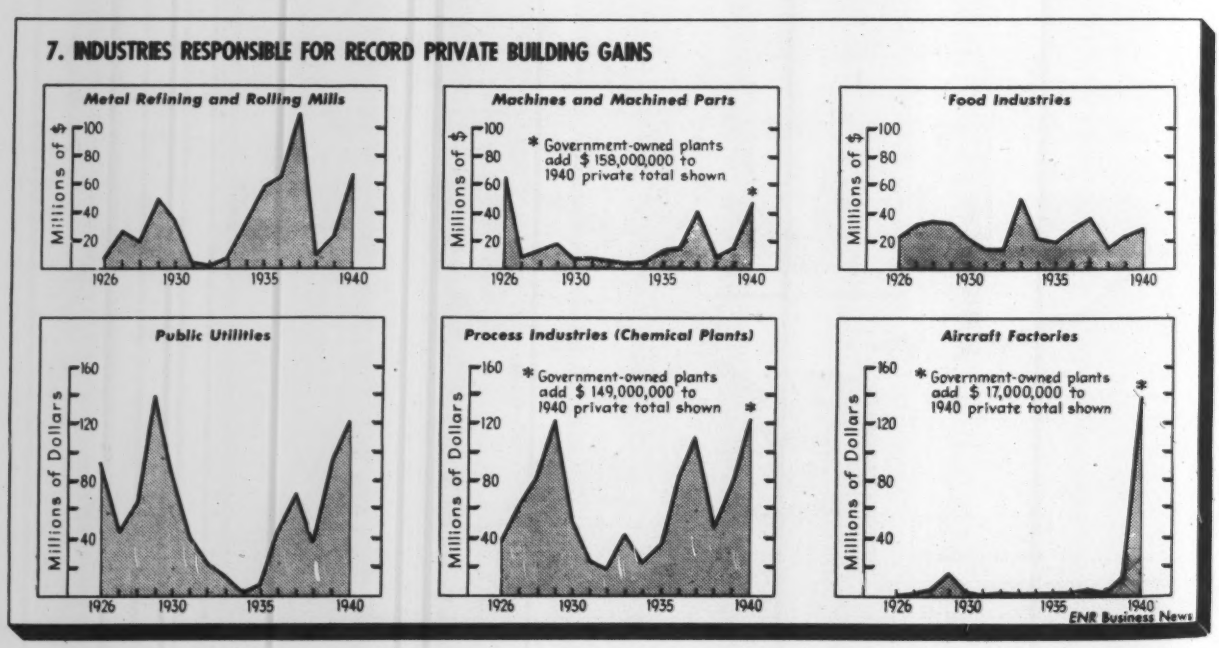
The combination of record awards in the *aircraft* and *process industries*, and near-record volume in *machine and machined part plants*, *public utilities* and *metal refining and rolling mills* brought industrial building to its new pinnacle. The defense emergency has created an unusual situation, in that many industrial plants are being erected with government funds under the supervision of private companies. Title to the plants so built remains with the government. In the *ENR* system of classifying buildings by ownership, these are classed as public rather than private industrial buildings. If classified by purpose instead of ownership, the $326,184,000 reported above for government-financed manufacturing plants would be part of the industrial total. Analysis of the federal factories by industries whose productive capacity they expand shows that $160,397,000 has been added for *machine and machined parts plants*; $148,862,000 for *process (chemical) industries* (principally ammunition); and $16,925,000 for *aircraft and engine plants*. These government-owned plant volumes

## IV—CONTRACTS FOR INDUSTRIAL BUILDING CONSTRUCTION BY INDUSTRIES

(Value in Thousands of Dollars ENR Reports)

| Transportation Service | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 No. | 1940 Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Railroads | ..... | ..... | ..... | ..... | ..... | ..... | $1,108 | $3,621 | $909 | $712 | $1,690 | $2,417 | $2,546 | $1,447 | 29 | $1,827 |
| 2. Automotive | $29,029 | $23,022 | $37,181 | $28,962 | $18,090 | $10,479 | 9,562 | 10,288 | 5,655 | 4,173 | 5,127 | 8,431 | 4,250 | 4,114 | 83 | 5,077 |
| Public Utilities | 91,621 | 43,860 | 64,373 | 151,033 | 86,137 | 40,813 | 22,800 | 14,290 | 1,741 | 7,577 | 42,481 | 70,765 | 37,658 | 94,822 | 107 | 121,155 |
| Process Industries (a) | 38,499 | 67,415 | 82,591 | 122,048 | 52,741 | 24,679 | 19,002 | 43,203 | 21,922 | 34,655 | 81,627 | 111,246 | 45,529 | 78,239 | 400 | 123,165 |
| Food Industries (b) | 22,070 | 30,827 | 32,957 | 32,138 | 21,289 | 14,311 | 14,385 | 50,038 | 20,674 | 19,655 | 28,639 | 36,248 | 13,838 | 23,049 | 352 | 28,292 |
| Metal Refining and Rolling | 6,180 | 26,847 | 19,014 | 48,920 | 34,083 | 3,515 | 745 | 6,979 | 31,609 | 59,075 | 65,505 | 111,426 | 8,590 | 22,340 | 95 | 66,390 |
| **Metal Working Plants** | | | | | | | | | | | | | | | | |
| 1. Auto Factories* | ..... | ..... | ..... | ..... | 6,380 | 3,120 | 3,735 | 331 | 1,709 | 3,553 | 17,410 | 21,763 | 2,665 | 1,562 | 30 | 5,535 |
| 2. Aircraft Factories | ..... | 211 | 4,361 | 14,818 | 2,230 | 75 | 418 | 128 | 30 | 425 | 915 | 4,312 | 590 | 11,037 | 107 | 137,656 |
| 3. Foundries | 3,442 | 2,852 | 4,752 | 4,150 | 2,146 | 1,686 | 188 | 465 | 368 | 1,952 | 1,541 | 1,890 | 335 | 1,819 | 30 | 2,050 |
| 4. Mach. and Mach. Parts (c) | 65,132 | 6,985 | 11,503 | 17,044 | 6,374 | 6,639 | 5,220 | 2,848 | 3,404 | 11,079 | 14 560 | 41,030 | 8,757 | 14,343 | 359 | 48,446 |
| **Textiles (excluding rayon)** | 13,280 | 46,134 | 9,103 | 9,705 | 3,300 | 2,427 | 2,047 | 2,781 | 1,431 | 2,216 | 3,421 | 5,017 | 2,089 | 3,714 | 39 | 1,931 |
| **Wood Industries** | 7,564 | 3,204 | 2,652 | 4,857 | 1,400 | 726 | 595 | 2,296 | 488 | 999 | 1,008 | 825 | 480 | 950 | 35 | 2,890 |
| **Miscellaneous** | | | | | | | | | | | | | | | | |
| 1. General Factories | 39,330 | 65,670 | 75,989 | 110,311 | 87,274 | 53,181 | 12,646 | 14,618 | 14,752 | 26,118 | 45,344 | 61,511 | 23,760 | 24,744 | 551 | 49,065 |
| 1. Refrig'n. and Cold Storage | 5,820 | 4,288 | 10,817 | 3,327 | 9,727 | 4,099 | 613 | 490 | 500 | 278 | 209 | 417 | 1,011 | 800 | 10 | 585 |
| **Total** | **$321,967** | **$321,315** | **$355,187** | **$547,313** | **$331,171** | **$165,750** | **$93,064** | **$152,376** | **$105,192** | **$172,467** | **$309,477** | **$477,298** | **$152,098** | **$282,980** | **2,227** | **$594,064** |

*Auto factories for years 1926, 1927, 1928 and 1929 are included under "Automotive"— Transportation Service.
(a) Includes Distilleries.
(b) Includes Breweries and Wineries.
(c) Includes Radio Plants.


7. INDUSTRIES RESPONSIBLE FOR RECORD PRIVATE BUILDING GAINS
Metal Refining and Rolling Mills
Millions of $
Machines and Machined Parts
* Government-owned plants add $ 158,000,000 to 1940 private total shown
Food Industries
Public Utilities
Millions of Dollars
Process Industries (Chemical Plants)
* Government-owned plants add $ 149,000,000 to 1940 private total shown
Aircraft Factories
* Government-owned plants add $ 17,000,000 to 1940 private total shown
1926
1930
1935
1940
ENR Business News

are not included in the yearly private industrial building totals shown in Table IV.

The new highway mark, 5 percent above the 1939 record held closely to the predicted 6 percent gain in state highway construction for the second year in a row. The forecast was based on budget estimates from 47 state highway departments.

### Three sectional records

Geographically, three new records were established in 1940. The Southern states, with a volume of $853,254,000, gained 88 percent over the previous high of 1939; Far West's total, $493,348,000, topped its mark of 1938 by 20 percent and was 59 percent above last year. West of Mississippi states, $702,222,000, exceeded the high established in 1927 by 18 percent, and were up 28 percent compared with a year ago.

New England, with $243,978,000, climbed 39 percent over 1939 to reach the greatest volume reported since 1930; and Middle West, $742,942,000, was 38 percent higher than last year, the top mark since 1929. Middle Atlantic volume, $951,499,000, was down 3 percent, the only section to drop behind 1939.

Despite its loss, Middle Atlantic continued to provide the greatest percentage of the nation's construction, 23.8 percent. South was a serious challenger, with 21.4 percent, followed by Middle West with 18.6 percent; West of Mississippi, 17.6 percent; Far West, 12.4 percent; and New England, 6.1 percent.

# Residential Building

More New Dwelling Units were provided in non-farm areas during 1940 than in any year since 1928. Early estimates by the Bureau of Labor Statistics reveal 545,000 new units were built, a 17 percent increase over 1939, and 7 percent higher than in 1929. All sections of the nation except Middle Atlantic participated in the gain.

Final figures on the type of units constructed are not available. At the end of three quarters of 1940, however, 314,579 were of the one-family type, 19.6 percent above 1939; 24,079 were two-family dwellings, up 51.4 percent; and 52,759 were multi-family, down 23.4 percent.

Of the total dwelling units built during the first nine months of the year 38,272, or 10 percent, were in public projects financed by USHA loans. This topped the 37,448 units reported for the period in 1939 by 2 percent. Defense housing projects begun by the Navy Department and the Public Buildings Administration added a considerable volume during the fourth quarter, and though data are not complete, indications are that publicly-financed housing will extend its gain over 1939.

In 1940 approximately 180,000 new units were completed or started under Federal Housing Administration sponsorship, a 27 percent gain over a year ago.

FHA mortgage selected for appraisal reached the total of $1,271,984,000 for the year, 13 percent higher than in 1939. New home construction was responsible for $990,259,000, exceeding last year's mark by 26.5 percent.

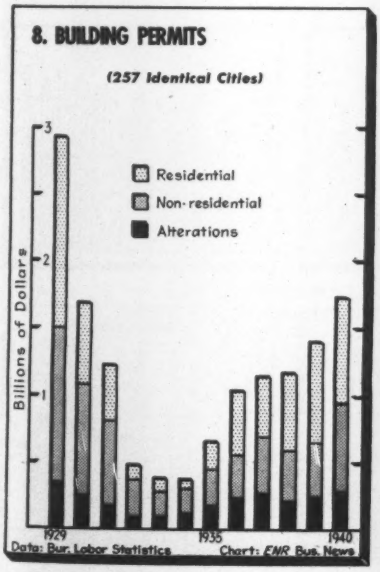
The trend of FHA home financing has climbed steadily since the inception of the program. In 1936 mortgages selected for appraisal averaged $44,900,000 per month; in 1937, $49,100,000; in 1938, $84,200,000; in 1939, $93,500,000; and in 1940, $106,000,000.

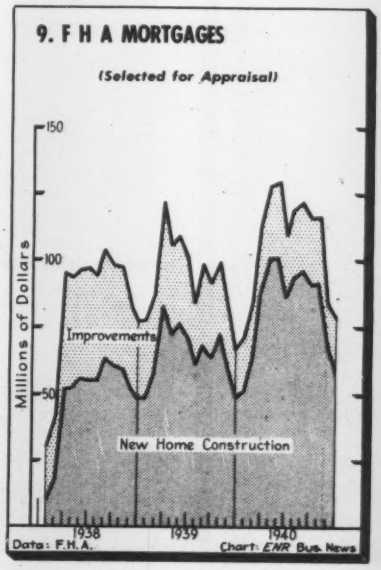
The portion of the money for new construction has also increased. In 1938, 58 percent was for new building; in 1939, 70 percent; and in 1940, 78 percent.

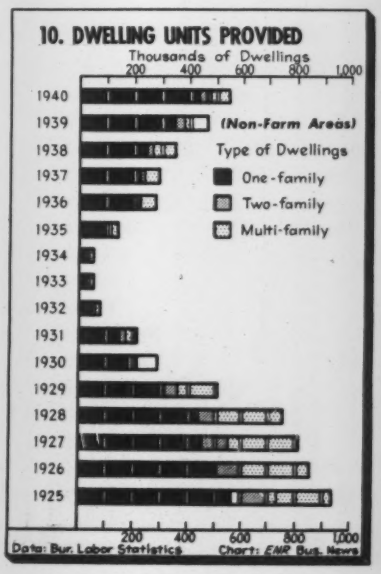
### Building Permits

Building permits for 257 identical cities rose to $1,780,000,000 in 1940, topping last year by 27 percent and reaching the highest level since 1929. Just under $800,000,000 of the total went for residential construction, an 11-year peak; approximately $738,000,000, for non-residential construction, the top since 1931; and the balance, $242,000,000, was for alterations.

New residential construction in the same cities gained 5 percent over 1939, and non-residential building climbed 14 percent, while spending for alterations declined 1 percent from a year ago.



# Employment and Materials

CONSTRUCTION EMPLOYMENT in 1940 rose 5.5 percent over 1939 according to estimates by the National Industrial Conference Board. These figures revealed that an average of 2,313,000 men were employed in the industry each month of 1940, the best level recorded since 1930 when an average of 2,842,000 men per month were at work.

The industry's employment total was consistently lower than 1939 during the first five months of the year but, with the advent of defense construction in June, rose to the highest peak in the last decade. The usual seasonal decline in the later months of the year was entirely averted by increased employment on defense projects.

Total employment estimates for all fields averaged 46,955,000 men per month, a 3.5 percent increase over 1939, and the top employment figure since 1929.

The trend of employment construction in Ohio, available for 10 months of the year, exactly parallels the national estimate for construction. Federal and state highway employment averages recorded a 14 percent increase over 1939.

### Construction material shipments

Construction material shipments began 1940 with moderate volumes compared with the early months of 1939 when materials for PWA projects boosted the totals. However, the pressure of defense construction in the last half of 1940 and the forward buying for non-defense projects to preclude stoppages due to defense priorities, had the effect of increasing shipments of major construction materials above last year.

Fabricated structural steel shipments ended the year 5 percent higher than in 1939; Portland cement shipments, the greatest since 1930, gained 7 percent over a year ago; and lumber shipments for 1940 were up 8 percent over the volume for the 1939 period, and the highest monthly average reported since 1929.

Production of steel ingots reached 65,247,000 net tons in 1940, an all-time high, and topped the previous record of 1929 by 7 percent.

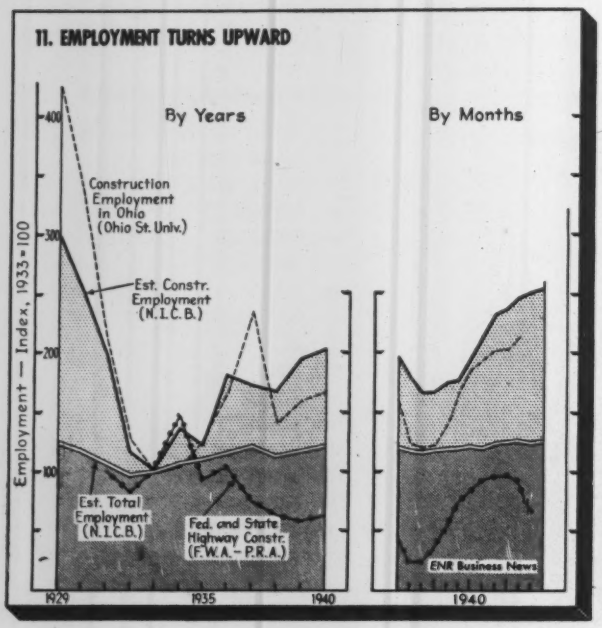
Common brick, vitrified paving brick, and prepared roofing shipments, though currently running above 1939 monthly figures, failed to overcome PWA-aided volumes of last year, and based on data available, are expected to end 1940 with losses of 3, 18 and 18.5 percent, respectively.

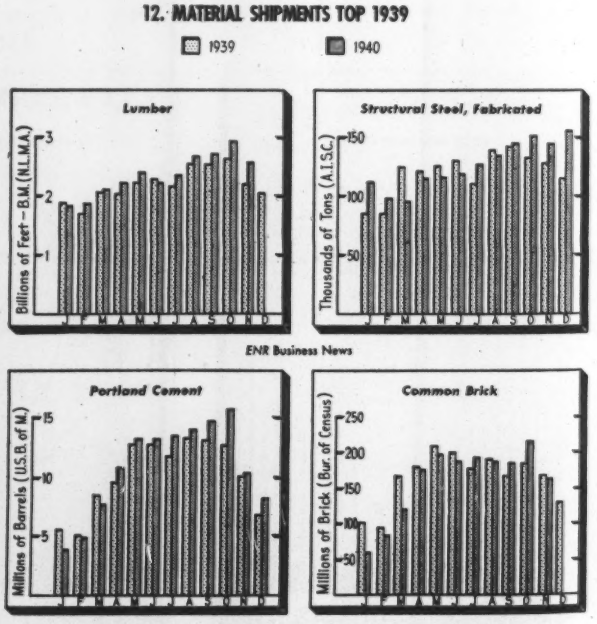
According to all indications, 1941 shipments of major construction materials should maintain their volumes of the later months of 1940. The tremendous demand created by the defense program was apparent only in the last few months of 1940, but with the program in full swing, and new money available for construction, the prospect becomes increasingly brighter.

**V—OUTPUT OF VARIOUS CONSTRUCTION MATERIALS FOR TEN YEAR PERIOD**

| Item | Basis | Unit | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | % Change '39 to '40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lumber | Production | Millions Bd. ft. | 16,523 | 10,824 | 14,700 | 15,492 | 19,539 | 24,355 | 25,997 | 21,646 | 25,259 | 26,968 | +7 |
| Cement | Shipments | Thous. Bbl. | 126,465 | 80,529 | 64,086 | 75,917 | 74,936 | 112,566 | 114,010 | 106,533 | 122,291 | 130,315 | +7 |
| Steel Ingots | Production | Thous. net Tons. | 28,216 | 14,922 | 25,305 | 28,671 | 37,428 | 52,425 | 55,443 | 31,071 | 51,585 | 65,247 | +26 |
| Fabricated Structural Steel | Shipments | Thous. Tons | 1,812 | 942 | 828 | 1,033 | 1,095 | 1,548 | 1,660 | 1,159 | 1,440 | 1,516 | +5 |
| Fabricated Steel Plate | New Orders | Thous. Tons | 303 | 162 | 198 | 242 | 258 | 484 | 429 | 285 | 357 | † | .... |
| Explosives | Shipments | Thous. lb. | 325,440 | 227,508 | 249,366 | 307,380 | 297,730 | 378,361 | 387,805 | 320,259 | 372,470 | 408,766* | +10 |
| Common Brick | Shipments | Millions | ..... | ..... | ..... | 637 | 952 | 1,720 | 1,806 | 1,537 | 1,966 | 1,905* | −3 |
| Vit. Paving Brick | Shipments | Thousands | ..... | ..... | ..... | 87,216 | 62,528 | 96,001 | 79,716 | 84,887 | 68,439 | 56,100* | −18 |
| Prepared Roofing | Shipments | Thous. squares | 22,560 | 23,220 | 24,732 | 24,000 | 26,052 | 32,237 | 29,942 | 34,610 | 34,227 | 27,900* | −18½ |

* Estimated Totals. † Temporary discontinued.





12. MATERIAL SHIPMENTS TOP 1939
1939
1940
Lumber
Billions of Feet – B.M. (N.L.M.A.)
Structural Steel, Fabricated
Thousands of Tons (A.I.S.C.)
ENR Business News
Portland Cement
Millions of Barrels (U.S.B. of M.)
Common Brick
Millions of Brick (Bur. of Census)
J F M A M J J A S O N D

# Construction Costs

CONSTRUCTION COSTS turned upward in mid-1940, and for the year averaged a 2.7 percent increase over 1939 as measured by the *ENR* Construction Cost Index. After six months of stability, the index rose from 238.86 in May to 249.12 in December, a 4.3 percent rise, and the highest index figure reported since December, 1920.

The common labor component of the index increased 3 percent during the May-December period, and the lumber component climbed 16.8 percent during the same seven months. Cement and structural steel factors of the index were unchanged.

The 1940 *ENR* Building Cost Index average 202.81, also topped the 1939 mark by 2.7 percent. A ten-month period of stable costs preceded its first important rise in September. The index climbed from 201.71 in August, just before the increase, to 208.19 in December, a 3.2 percent gain. The skilled labor component of the building cost index increased 0.3 percent in the four-month period, and lumber rose 17.1 percent.

A comparison of *ENR* Cost Indexes with four other building cost indexes (Table VI) shows similar trends for all in 1940, but there was a variation in the size of the increases reported over 1939. The Turner Construction Cost Index for eastern cities was 6 percent higher than last year; American Appraisal Co. Index (30-cities average) rose 2 percent; George A. Fuller Co. Index was up 1 percent; and the Aberthaw Co. Index of building costs in New England gained 1.5 percent.

### Labor rates gain

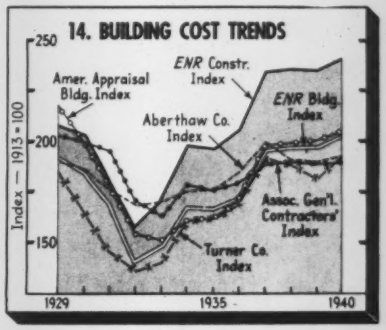
Construction wage averages in the common labor field opened 1940 at 68.5c. per hour. This 20-city average rate was unchanged until May when it climed to 69c. The June average rose to 70.3c.; the July and August rates were 70.7c. In September the wage increased to 71.1c., a level which has been maintained since that time.

The result was a new record average hourly rate of 69.9c. per hour for 1940, an increase of 2.3 percent over 1939.

The skilled construction average rate for 20 cities followed a more even pattern than common labor. The skilled wage average began the year at $1.465 per hour, the rate which held to May. Minor increases were reported in May, June, July and September, and the rate finally wound up at $1.481 for December.

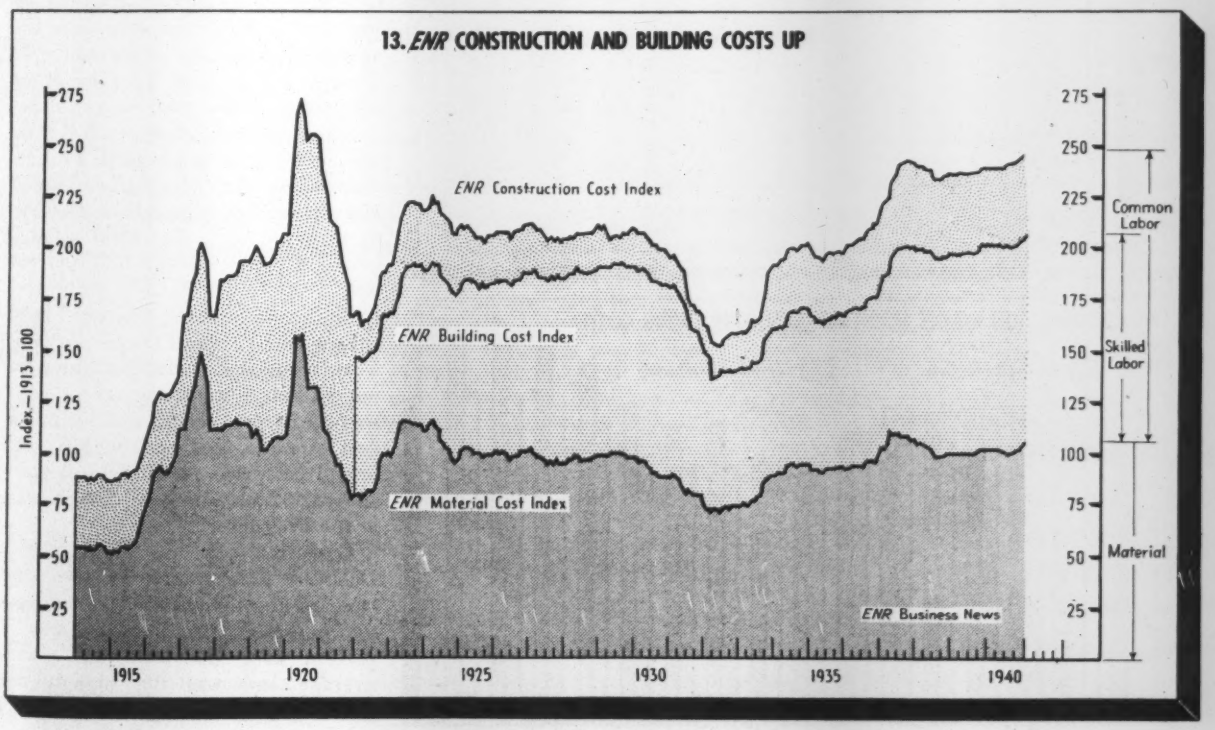
The 1940 average for skilled labor, $1.473, a new all-time high, was 2.1 percent above the preceding year.

All three trades, which combine to make the *ENR* skilled average rate, topped their respective 1939 wage levels. Bricklayers' rate, $1.566, rose 2.4 percent; carpenters' wage, $1.323, and structural ironworkers'

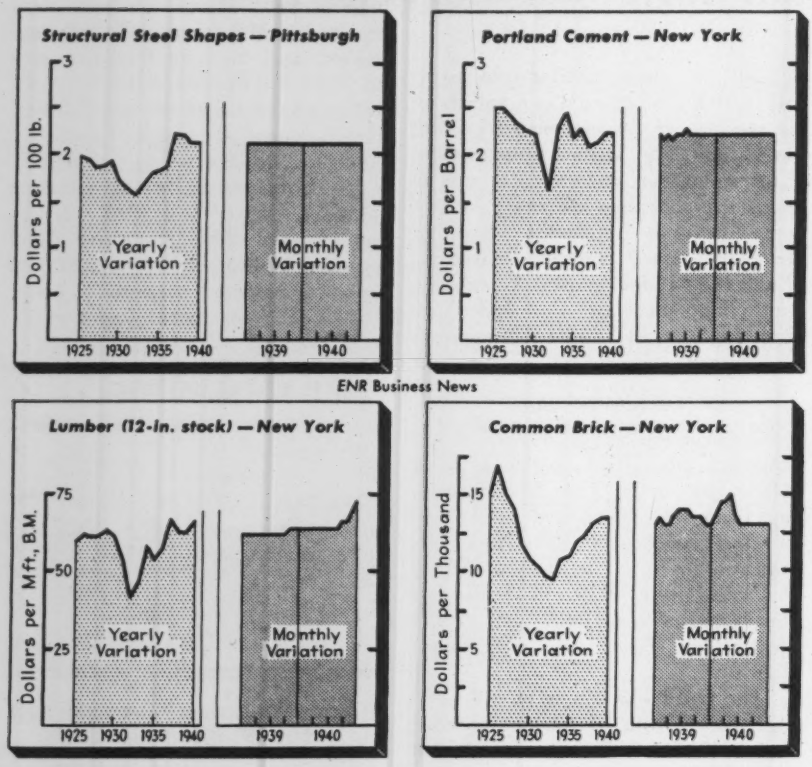



**VI—CONSTRUCTION AND BUILDING COST INDEXES COMPARED**

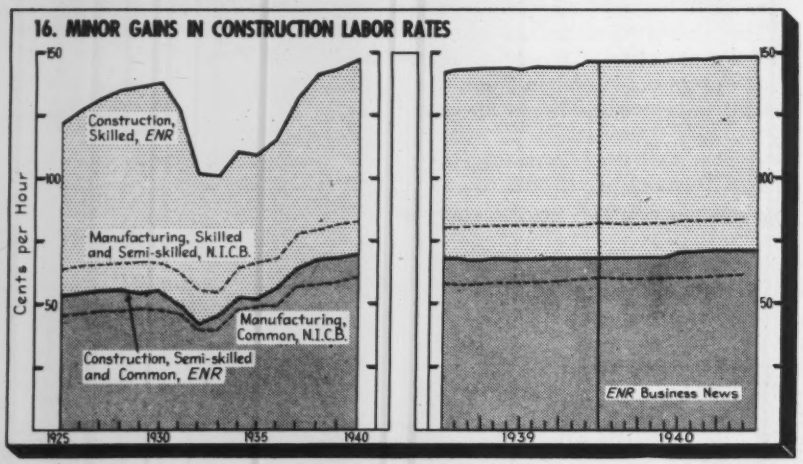
| | Aver. 1929 | Aver. 1932 | Aver. 1940 | Dec 1940 |
|---|---|---|---|---|
| *E N R* Construction | 207 | 157 | 242 | 249 |
| *E N R* Building | 191 | 141 | 203 | 208 |
| Amer. Appraisal (Bldg.) | 217 | 156 | 204 | 212 |
| Aberthaw (Bldg.) | 190 | 168 | 193 | 195 |
| Turner (Bldg.) | 185 | 136 | 193 | 204 |
| Fuller (Bldg.) | 201 | 157 | 196 | 199 |



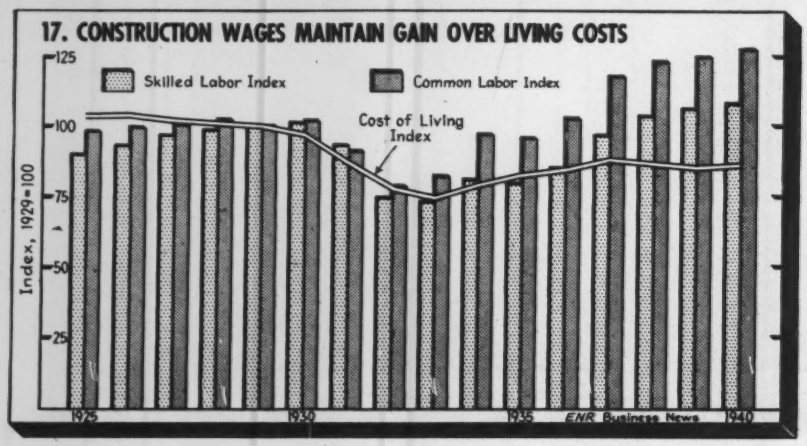
## 15. MATERIAL PRICE TRENDS MIXED




## 16. MINOR GAINS IN CONSTRUCTION LABOR RATES


Cents per Hour
Construction, Skilled, ENR
Manufacturing, Skilled and Semi-skilled, N.I.C.B.
Manufacturing, Common, N.I.C.B.
Construction, Semi-skilled and Common, ENR
ENR Business News
1925 1930 1935 1940 1939 1940

## 17. CONSTRUCTION WAGES MAINTAIN GAIN OVER LIVING COSTS




average hourly earnings, $1.529, were each 1.9 percent higher than a year ago.

The common labor wage in manufacturing industries increased at a slightly faster pace than common labor in the construction industry, and gained 2.7 percent over last year. Manufacturing skilled hourly rates exactly paralleled the construction skilled average rise of 2.1 percent, according to the National Industrial Conference Board. Comparison of yearly and seasonal statistics are shown in Chart 16.

Real income, that is, actual wages in relation to living costs continued to improve slightly for construction workers. The 1940 index of wage rates for the construction industry based on 1929 as 100 stood at 128 for common labor and 108.3 for skilled labor, gains of 2.3 and 2.1 percent, respectively, over 1939. The index of living costs released by the National Industrial Conference Board increased 0.9 percent over a year ago, cutting into, but not overcoming the average construction wage rate gains reported by *E.N.R.*

### Construction material prices

Construction material prices in New York revealed mixed trends during 1940. Long Leaf Yellow Pine opened at $64 per M ft., held at that level through August, then climbed to $72.50 by December. The net result was a 5 percent gain over the average reported for 1939 and a 13 percent increase over the price at the beginning of the year.

Common brick prices reached their peak of $15 per M in April. By June they decreased to $13, the level which was maintained throughout the balance of the year. The 1940 average price, $13.50, was up 0.3 percent over 1939.

The quotations for structural steel shapes and Portland cement in New York remained unchanged throughout the year. Cement average for 1940 was $2.20 per barrel, not including cost of sacks, just even with a year ago. Base price for structural steel shapes, $2.10 per 100-lb., also was at the 1939 level.

Cast iron pipe quotations, f.o.b. Delaware River foundries, were unchanged throughout the year at $49 per net ton. This, however, was 5 percent over the preceding year's average and was the highest reported since 1925.

# MATERIALS AND LABOR PRICES

***Market quotations on construction materials and wage rates reported monthly by ENR correspondents***

FEBRUARY LUMBER prices continue to provide the most important changes in the construction material list, but the trend is mixed. Short leaf yellow pine is $1.50 to $2.00 higher in Baltimore; $2.00 to $3.00 higher in St. Louis; up $1.00 to $2.00 on 2-in. sizes in Chicago; and $2.00 to $3.00 higher on the same sizes in Cincinnati. Pine is off, however, from $1.00 to $2.00 in Birmingham and Kansas City. Douglas Fir is $2.00 higher in Baltimore, and up the same amount on 2-in. sizes in New York. Long leaf yellow pine is $1.00 to $2.00 lower on most sizes in Birmingham.

Cement is 27c. per barrel lower in Cincinnati, the only change in the twenty cities. Crushed stone is off 10c. per ton in Atlanta and St. Louis.

Structural steel shapes rose 5c. per 100 lb. in Detroit, and 22c. in St. Louis. The base price, however, remains unchanged.

Carpenters' rate in Boston which formerly ranged from $1.00 to $1.25 per hour, has closed up, and the top rate now prevails. The new common labor rate on heavy construction in San Francisco is 85 to 87.5c., replacing the 81.3c. formerly quoted.

## CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

| | PORTLAND CEMENT | | | SAND AND GRAVEL | | | CRUSHED STONE | | CRUSHED SLAG | | CONCRETE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted | | | Per ton, carload lots | | | Per ton, carload lots | | Per ton, carload lots, f.o.b. plant | | Ready Mixed 1:2:4, 50 c.y. or more, delivered |
| | Cloth Bags *a* | Paper Bags | Bulk | Gravel, 1½ in. | Gravel, ¾ in. | Sand | 1½ in. | ¾ in. | 1½ in. | ¾ in. | |
| Atlanta | $2.90 | $2.66 | $2.61 | $1.75 | $1.85 | $1.95 | $1.75 | $1.85 | $1.55 | $1.65 | $7.90 |
| Baltimore | 2.31 | 2.06 | 1.86 | 1.75‡ | 1.75‡ | 1.25‡ | 1.75‡ | 1.75‡ | 1.75‡ | 1.75‡ | 6.75 |
| Birmingham | 2.50 | 2.25 | 2.05 | 1.75 | 1.75 | 1.50 | 1.00 | 1.00 | .90 | 1.15 | 5.80 |
| Boston | 2.75*b* | 2.50*b* | 2.30 | 1.20‡ | 1.20‡ | .90‡ | 1.20‡ | 1.20‡ | .... | .... | 6.75*m* |
| Chicago | 2.60 | 2.35 | 2.20 | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 1.25‡ | 1.25‡ | .... |
| Cincinnati | 2.31 | 2.06 | 1.81 | 1.20 | 1.20 | 1.10 | 1.80 | 1.80 | .... | .... | 6.30 |
| Cleveland | 2.00 | 1.75 | .... | 1.45*i* | 1.45*i* | 1.30*i* | 1.70*i* | 1.70*i* | 1.70*i* | 1.70*i* | 6.55*i* |
| Dallas | 2.47 | 2.22 | 2.02 | 1.75*p* | 2.00*p* | 1.25*p* | 1.69*p* | 1.84*p* | .... | .... | 6.20 |
| Denver | 3.08 | 2.83 | .... | 1.20 | 1.40 | .90 | .... | .... | .... | .... | 7.25 |
| Detroit | 2.24 | 1.99 | 1.79 | 1.55 | 1.65 | .95 | 1.55 | 1.65 | 1.30‡ | 1.40‡ | 6.50 |
| Kansas City | 2.56 | 2.31 | 2.16 | 1.85 | 2.30 | 1.00 | 1.91 | 1.91 | .... | .... | 7.25*n* |
| Los Angeles | 2.25*b* | 2.05*b* | .... | 1.00 | 1.00 | 1.00 | 1.00*f* | 1.00*f* | .... | .... | 5.85 |
| Minneapolis | 2.90 | 2.65 | .... | 1.00*h* | 1.00*h* | .25*h* | 1.00*h* | 1.00*h* | .... | .... | 7.60*f* |
| Montreal | .... | 1.82*r* | 1.67*r* | .... | .... | 1.25‡ | .85‡*c* | 1.00‡*c* | .... | .... | 6.45*f* |
| New Orleans | 2.41 | 2.16 | 1.96 | 1.50 | 1.50 | 1.25 | .... | .... | .... | .... | 7.25 |
| New York | 2.55‡ | 2.30‡ | .... | 1.25*de* | 1.25*de* | .75*de* | 1.65*de* | 1.75*de* | .... | .... | 6.50 |
| Philadelphia | 2.32 | 2.07 | 1.87 | 1.55‡ | 1.65‡ | 1.25‡ | .... | .... | 1.00 | 1.00 | 7.95*k* |
| Pittsburgh | 2.44 | 2.19 | 1.99 | 1.40‡ | 1.40‡ | 1.70‡ | 2.25‡ | 2.25‡ | 1.50 | 1.50 | 7.50 |
| St. Louis | 2.55 | 2.30 | .... | 1.50‡ | 1.50‡ | 1.25/1.50‡ | 1.00*h* | 1.00*h* | .75*g* | .75*g* | 7.50 |
| San Francisco | 2.16 | 1.96 | 1.66 | 1.36 | 1.36 | 1.36 | 1.46 | 1.46 | .... | .... | 6.95 |
| Seattle | 2.95*o* | 2.70*o* | .... | 1.00*o* | 1.00*o* | 1.00*o* | 2.00*o* | 2.00*o* | .... | .... | 7.25 |

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery. 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

### CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

| | Bagged | Bulk | | Bagged | Bulk | | Bagged | Bulk |
|---|---|---|---|---|---|---|---|---|
| Buffington, Ind. | $1.70 | $1.65 | Ironton, Ohio | $1.60 | $1.55 | Richard City, Tenn. | $1.80 | $1 75 |
| Dallas, Tex. (Inc. 5c. tax) | 1.80 | 1.75 | Limedale, Ind. | 1.70 | 1.65 | Steelton, Minn. | 1.80 | 1.75 |
| Hannibal, Mo. | 1.70 | 1.65 | Norfolk, Va. | 1.65 | 1.60 | Universal, Pa. | 1.65 | 1.60 |
| Hudson, N. Y. | 1.75 | 1.70 | Northampton, Pa. | 1.55 | 1.50 | Waco, Tex. (5c. tax in Tex.) | 1.75 | 1.70 |
| Independence, Kans. | 1.70 | 1.65 | North Birmingham, Ala. | 1.70 | 1.65 | Montreal | 1.55 | 1.55 |

## PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

| | PAVING BRICKS AND BLOCKS | | | PAVING ASPHALT | | ASPHALT BINDERS—FLUXES | | CUTBACK ASPHALT | | ROAD OILS | ASPHALT EMULSION (Quick-breaking) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Granite per M. lots of 50,000 4x4x8 in. | Brick per M. 3¾x4x8½ in. carload lots | Wood per sq. yd. 3½ in. 16-lb. treat | Per ton, less than 80 penetration | | Per gal., 80-300 penetration | | Per ton | | Per gal. | Per gal. |
| | | | | Tank car | Drums | Tank car | Drums | Tank car | Drums | Tank car | Tank car | Drums |
| Atlanta | $73.00 | $39.35 | $2.25 | $17.30*e* | $23.83*e* | $0.0695*e* | $0.1018*e* | $0.0734*he* | $0.1257*h* | $0.0634*e* | $0.0734 | $0.1257 |
| Baltimore | 150.00‡ | 45.00‡ | 2.75 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | ..... | ..... | ..... |
| Birmingham | ..... | 27.50*j*‡ | .... | 18.20 | 23.20 | .0747 | .1047 | .0834*h* | .1484*h* | ..... | ..... | ..... |
| Boston | 85.00 | 47.50 | 3.00 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | .065 | .09‡ | .12‡ |
| Chicago | 135.00 | 45.00 | 1.85*d* | 14.50 | 18.50 | 13.00*g* | 17.00*g* | .06*h* | .10*h* | .04 | .09 | .125 |
| Cincinnati | 112.00 | 37.50 | .... | 13.50 | 17.50 | .07 | ..... | 16.80 | ..... | .0525 | ..... | .075*l* |
| Cleveland | 110.00 | 37.50 | 2.25 | 15.00 | 20.00 | .065 | .075 | .075*h* | .085*h* | .035 | .08 | .09 |
| Dallas | ..... | 30.00 | .... | 13.25 | 20.30 | .06 | .103 | 15.00 | 24.80 | .055 | .05/.07 | .07/.09 |
| Denver | ..... | 27.50 | .... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Detroit | ..... | 35.00 | .... | 13.15*f* | 18.45*f* | .061 | .0984 | 13.15 | 17.20 | .0475 | .061 | .0923 |
| Kansas City | ..... | 40.00 | .... | 18.50 | 23.50 | .077 | .1075 | .077*h* | .107*h* | .057 | .11 | .15 |
| Los Angeles | ..... | 50.00 | .... | 6.50*b* | 15.00 | 6.50*bg* | 15.00*bg* | 5.50*b* | ..... | .0192 | .0525 | .1125 |
| Minneapolis | ..... | ..... | 1.90*d* | 19.20 | 24.20 | .10 | .12 | 19.30 | 28.30 | .056 | ..... | ..... |
| Montreal | 75.00 | ..... | 3.62 | 16.60 | 24.25 | .116 | .1483 | .115*h* | .135*h* | .08 | .135 | .188 |
| New Orleans | ..... | ..... | .... | 14.00*a* | 19.00*a* | .055 | .085 | .06*h* | .09*h* | ..... | .078 | ..... |
| New York | ..... | ..... | 2.90 | 15.00 | 21.00 | .06 | .09 | .065*h* | .115*h* | ..... | .07 | .11 |
| Philadelphia | 120.00 | 42.50 | 2.84 | 14.00 | 19.00 | .055 | .08 | .06*h* | .09*h* | .05 | .06 | .09 |
| Pittsburgh | 135.00 | 38.75 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| St. Louis | 110.00/121.00 | 37.00 | .... | 14.00 | 19.00 | 14.00*g* | 19.00*g* | .06*h* | .095*h* | .04 | .09 | .125 |
| San Francisco | ..... | 70.00 | .... | 6.50 | 15.00 | 6.50*g* | 15.00*g* | 7.00 | 17.50 | .025 | .0525 | .1125 |
| Seattle | ..... | 60.00*c* | .... | 15.70 | 25.10 | ..... | 24.10*g* | 10.50/11.50 | 24.00/25.00 | 8.85*g* | .0575*i* | .1308*i* |

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3¾x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3½x8½ in.

## IRON AND STEEL PRODUCTS—BASE MILL PRICES

| | STRUCT. SHAPES-PLATE | REINF. BARS ¼-in. billet *b* | RIVETS ½-in. structural | WIRE NAILS Base *d* | SHEET PILING Base | STEEL RAILS Per Gross Ton | | | TRACK SUPPLIES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Standard | Light | Re-rolled | Angle Bars | Std. Spikes *c* | Tie Plates *c* | Track Bolts |
| Birmingham | $2.10 | $2.15 | $3.40 | $2.55 | ..... | $40.00 | $40.00 | $39.00 | $2.70 | $3.00 | $2.15 | $4.15 |
| Chicago | 2.10 | 2.15 | 3.40 | 2.55 | $2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Pittsburgh | 2.10 | 2.15 | 3.40 | 2.55 | 2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Buffalo | 2.10 | 2.15 | ..... | ..... | 2.40 | ..... | ..... | ..... | ..... | ..... | 2.15 | ..... |
| Cleveland | 2.10 | 2.15 | 3.40 | 2.55 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Youngstown | ..... | 2.15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.00 | ..... | ..... |
| Detroit | ..... | 2.25‡ | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Gulf ports | 2.45*a* | 2.50*a* | ..... | ..... | 2.85*a* | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Pacific ports | 2.75*a* | 2.55*a* | ..... | ..... | 2.95*a* | ..... | ..... | ..... | ..... | ..... | 2.30 | ..... |

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. charge $18 per c.l. *d* Add switching

## IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

| | STRUCTURAL SHAPES Per 100 lb. base price | REINFORCING BARS* Per 100 lb., ¼ in., base price 15 tons or over *b* New billet | Rail steel | Add Switch | $/cwt. for Del. | EXPANDED METAL LATH —Per 100 sq.yd.. carload lots— Std. diamond mesh, 3.4 lb. | Std. ribbed 3.4 lb. | WELDED FABRIC REINFORCING —Per 100 s.f.. carload lots— 4x16 in., No. 5 & 10 wires | 4x12 in., No. 8 & 12 wires | 6x6 in. No. 6 & 6 wires Per sq. yd. | SHEET PILING Per 100 lb. base price |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $2.34 | $2.39 | $2.39 | .02½ | .10 | $21.00 | $23.00 | $1.82 | $1.35 | $0.1719 | $3.04 |
| Baltimore | 3.70 | 2.90 | 2.75 | ..... | .10 | 24.00 | 26.00 | 1.70 | 1.27 | .1611 | 2.90 |
| Birmingham | 2.10*a* | 2.15 | 2.15 | .02½ | .10 | 20.50 | 22.50 | 1.80 | 1.34 | .1701 | .... |
| Boston | 3.85 | 2.61 | 2.51 | $20 C.L. | .10 | 22.00 | 24.00 | 1.76 | 1.31 | .1656 | 2.77 |
| Chicago | 2.10*a* | 2.15 | 2.05 | .03 | .05 | 20.00 | 22.00 | 1.67 | 1.25 | .1575 | 2.40 |
| Cincinnati | 3.68 | 2.46*cd* | 2.36*cd* | ..... | .05 | 21.50 | 22.50 | 1.66 | 1.25 | .1566 | .... |
| Cleveland | 3.58*g* | 2.15 | 2.15 | .02½ | .10 | 19.50 | 21.50 | 1.66 | 1.25 | .1566 | .... |
| Dallas | 4.60 | 3.25 | 3.25 | ..... | ..... | 22.50 | 24.50 | 1.93 | 1.42 | .1827 | .... |
| Denver | 4.35 | 3.95 | 3.80 | ..... | ..... | 23.50 | 25.50 | 1.97 | 1.45 | .1863 | .... |
| Detroit | 3.65‡ | 2.25 | 2.15 | ..... | .10 | 22.50 | 24.50 | 1.68 | 1.26 | .1584 | 2.66 |
| Kansas City | 4.00 | 2.51*cd* | 2.36*cd* | .0 | .05 | 16.50 | 20.00 | 1.78 | 1.33 | .1683 | 2.86 |
| Los Angeles | 3.65*f* | 2.25 | 2.10 | .02½ | .05 | 23.00 | 27.50 | 1.93 | 1.42 | .1827 | 3.65 |
| Minneapolis | 3.80‡ | 2.48*c* | 2.33*c* | .0 | .10 | 20.50/21.50 | 22.50/23.50 | 1.80 | 1.34 | .1701 | 2.73*d* |
| Montreal | 3.90 | 2.65 | 2.55 | ..... | ..... | ..... | ..... | 2.58 | 3.22 | .264 | 2.58 |
| New Orleans | 4.40 | 2.52 | 2.52 | .05 | .10 | 21.50 | 23.50 | 1.82 | 1.35 | .1719 | 2.875 |
| New York | 3.75 | 2.39 | 2.29 | ..... | .10 | 15.50 | 17.50 | 1.76 | 1.32 | .1665 | 2.74 |
| Philadelphia | 3.55 | 2.66 | 2.56 | ..... | ..... | 19.50 | 21.50 | 1.71 | 1.28 | .1611 | 2.72 |
| Pittsburgh | 2.10*a* | 2.15 | 2.05 | .02½ | .10 | 21.50 | 24.50 | 1.59 | 1.20 | .1503 | 2.40 |
| St. Louis | 3.09 | 2.39 | 2.29 | .0 | .05 | 24.00 | 28.00 | 1.69 | 1.27 | .1602 | 2.70 |
| San Francisco | 3.50 | 2.50 | 2.35 | .02½ | .10 | 19.00 | 25.50 | 1.93 | 1.42 | .1827 | 3.25 |
| Seattle | 2.75*e* | 2.50*e* | ..... | ..... | ..... | 25.50 | 27.50 | 1.93 | 1.42 | .1827 | 2.95*e* |

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

## PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

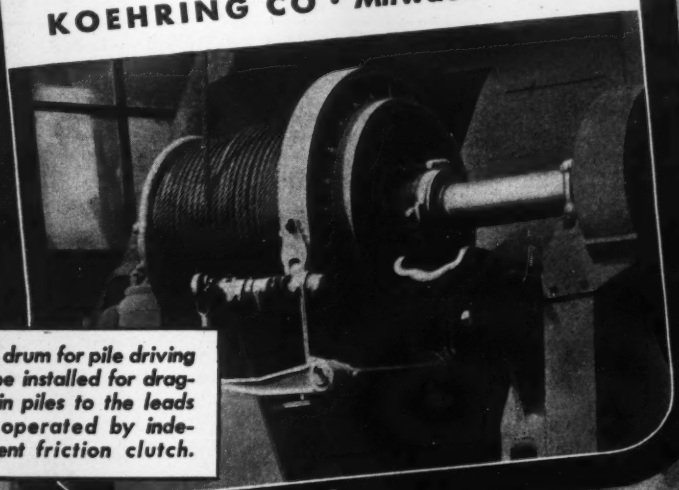
| | C. I. PIPE | VITRIFIED SEWER PIPE | | | | CLAY DRAIN TILE | | CONCRETE SEWER PIPE | | WROUGHT STEEL PIPE Full standard weight, *h* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per net ton f.o.b. 6 in. to 24 in.*a* | Per foot, std. 8 in., s.s. | delivered std. 12 in., s.s. | ASTM 24 in., | C13–35 36 in., | Per 1,000 ft., carload lots, f.o.b. 6 in. | 8 in. | Per ft., delivered; ASTM 12 in. | C 14–35 24 in. | 1 to 2 in., Butt Weld Black % | Galv. % | 3½ to 6in.; Lap Weld Black % | Galv. % |
| Atlanta | $49 40 | $0.26*b* | $0.468*bc* | $1.8525 | $4.68*c* | $85.00 | $128.00 | $0.45 | $1.642 | 62.2 | 54.2 | 59.7 | 51.2 |
| Baltimore | 52.80 | .35 | .60 | 2.30 | 6.80 | 115.00 | 150.00 | .60 | 1.90 | 65.5 | 57.5 | 63.00 | 54.5 |
| Birmingham | 45.00 | .26 | .468 | 1.7875 | 4.66 | 85.00 | 220.00 | .40 | 1.60 | 62.2 | 54.2 | 59.7 | 51.2 |
| Boston | 55.00 | .203 | .3645 | 1.98 | 5.64 | 133.50‡ | 223.50‡ | .45 | 2.00 | 64.1 | 56.1 | 61.6 | 53.1 |
| Chicago | 53.80 | .28 | .54 | 2.25 | 6.25 | 100.00‡ | 150.00‡ | .38 | 1.48 | 67.0 | 59.0 | 63.5 | 55.0 |
| Cincinnati | 52.70 | .196 | .378 | 1.485 | 4.510 | 105.00 | 170.00 | .60 | 1.70 | 65.9 | 57.9 | 63.4 | 54.9 |
| Cleveland | 54.24 | .182 | .351 | 1.395 | 4.305 | 69.00 | 108.00 | .35 | 1.50 | 67.8 | 59.8 | 65.3 | 56.8 |
| Dallas | 58.20 | .28 | .504 | 2.016 | 4.70 | 80.00 | 100.00 | .46 | 1.57 | 59.9 | 51.9 | 57.3 | 48.3 |
| Denver | 60.60 | .24† | .52† | 2.16† | ..... | 130.00 | 240.00 | .... | .... | 58.4 | 50.4 | 55.7 | 47.2 |
| Detroit | 54.24 | .245 | .4725 | 1.935 | 4.408 | 66.45 | 105.00 | .33 | 1.50 | 66.3 | 58.3 | 63.8 | 55.3 |
| Kansas City | 55.12 | .30 | .54 | 2.16 | 5.00 | 120.00 | 240.00 | .45 | 1.60 | 62.9 | 54.9 | 60.0 | 51.5 |
| Los Angeles | 55.00 | .282† | .508† | 2.034† | 5.085† | 115.50 | 192.50 | 1.00 | 2.00 | 59.6 | 51.6 | 57.0 | 48.6 |
| Minneapolis | 57.20 | .24† | .432† | 1.728† | 4.60† | ..... | ..... | .70 | 1.80 | 64.2 | 56.2 | 60.7 | 52.2 |
| Montreal | 60.00 | .55 | .90 | 3.68 | 5.95*e* | 135.00‡ | 260.00‡ | .48 | 1.92 | ..... | ..... | ..... | .... |
| New Orleans | 51.38 | .26 | .48 | 1.69 | ..... | 150.00 | 220.00 | .37 | 2.10 | 62.4 | 54.4 | 58.8 | 50.3 |
| New York | 52.20 | .30 | .61 | 2.30 | 5.90 | ..... | ..... | .50 | 1.20 | 64.9 | 56.8 | 62.4 | 53.9*i* |
| Philadelphia | 50.90 | ..... | ..... | ..... | ..... | ..... | ..... | .54 | 1.80 | 65.3 | 57.3 | 62.8 | 54.3 |
| Pittsburgh | 55.60 | .245† | .4725† | 1.845† | 5.4325 | 97.80 | 154.20 | .85*g* | 2.00*g* | 68.5*i* | 60.5*i* | 66.0*i* | 57.5 |
| St. Louis | 52.48 | .24 | .432 | 1.728 | 3.96 | 85.00 | 170.00 | .80*j* | 1.60*k* | 65.1 | 57.1 | 62.0 | 53.5 |
| San Francisco | 55.00 | .3275*d* | .5895*d* | 2.358 | 5.895 | 107.25 | 178.75 | .54 | 2.50 | 57.6 | 49.2 | 54.8 | 46.0 |
| Seattle | 55.35 | .35 | .63 | 2.52 | 6.30 | 72.00 | 175.00 | .35*f* | 1.30*f* | ..... | ..... | ..... | .... |

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¾ in., 8½c.; 1 in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest ptice at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

# ALL PURPOSE FOR JOB PROFIT

Keep your investment down by having a Koehring on your job . . . quickly convertible for all work . . . one machine for all jobs. Use it for excavating of all types . . . shovel, clamshell, or dragline . . . handling material, steel, piling, concrete buckets, forms. Easy steering and moving in tight spots, accurate boom control, stable operation, and quick moves on or between work locations are Koehring advantages for speeding up the work and increasing profit. Increase your profit with an All Purpose Koehring.

**KOEHRING CO · Milwaukee, Wis.**



*Third drum for pile driving can be installed for dragging in piles to the leads . . . operated by independent friction clutch.*

KOEHRING HEAVY DUTY

**HEAVY-DUTY CONSTRUCTION EQUIPMENT**

## LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

| | SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics) | | | | | | | | | LONG LEAF Y. P. Merchantable grade up to 20 ft. | | PLYWOOD* Rail freight increment (See note for base price) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1x6 S&S | 1x8 S&S | 2x4 S&S | 2x6 S&S | 2x8 S&S | 2x10 S&S | 3x12 R&K | 6x12 R&K | 12x12 R&K | 2x12 R&K | 12x12 R&K | 5/8" | 3/4" |
| Atlanta | $32.00 | $32.00 | $27.00 | $28.50 | $28.50 | $32.00 | $32.50 | ..... | ..... | $45.00 | $55.00 | $17.75 | $21.60 |
| Baltimore | 39.00 | 40.00 | 40.00 | 41.00 | 41.00 | 42.00 | 54.00 | ..... | ..... | 78.00 | 80.00 | 17.35g | 21.15g |
| | *41.00* | *41.00* | *43.00* | *43.00* | *43.00* | *43.00* | *54.00* | *$56.00* | *$56.00* | ..... | ..... | ..... | ..... |
| Birmingham | 32.00 | 33.00 | 29.00 | 30.00 | 30.00 | 32.00 | 42.00 | 42.00 | 52.00 | ..... | ..... | 16.25 | 19.85 |
| [1] | 37.00 | 37.00 | 35.00 | 34.00 | 34.00 | 38.00 | 58.00 | ..... | ..... | 55.00 | 58.00 | ..... | ..... |
| Boston | 40.00[2] | 40.00[2] | 40.00[2] | 40.00 | 60.00[1] | 65.00[1] | 77.00[1] | ..... | ..... | 77.00 | 77.00 | 17.35g | 21.15g |
| | *58.00* | *58.00* | *40.00* | *40.00* | *40.00* | *43.00* | *45.00* | *45.00* | *60.00* | ..... | ..... | ..... | ..... |
| Chicago | 42.00 | 42.00 | 39.00 | 39.00 | 40.00 | 43.00 | 52.00 | ..... | ..... | 90.00 | 100.00 | 13.80 | 16.80 |
| | *40.00* | *40.00* | *40.00* | *41.00* | *41.00* | *42.00* | *45.00* | *45.00* | *47.50* | ..... | ..... | ..... | ..... |
| Cincinnati | 37.50 | 39.00 | 38.00 | 38.00 | 38.00 | 41.00 | 50.00 | ..... | ..... | 60.00 | 63.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | ..... | ..... | ..... | *52.00* | *52.00* | *52.00* | ..... | ..... | ..... | ..... |
| Cleveland | 40.00 | 41.00 | 41.00 | 39.00 | 38.00 | 43.00 | 50.00 | 50.00 | 50.00 | 83.00 | 83.00 | 16.70 | 20.40 |
| Dallas *e* | 38.00 | 39.00 | 38.00 | 36.00 | 37.00 | 38.50 | 52.50 | 52.50 | 52.50 | 76.00 | 81.00 | 13.90 | 16.95 |
| Denver ‡ | 47.00[4] | 46.00[4] | 50.00[4] | 50.00[4] | 50.00[4] | 52.00[4] | 52.00[4] | 64.00[4] | 69.00[4] | ..... | ..... | 9.90 | 12.05 |
| Detroit | 42.00 | 42.00 | 40.00 | 42.00 | 42.00 | 44.00 | 51.00 | ..... | ..... | 50.00 | 59.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | ..... | ..... | *49.00* | *52.00* | *59.00* | *59.00* | ..... | ..... | ..... | ..... |
| Kansas City | 41.50 | 41.50 | 38.00 | 38.00 | 38.00 | 41.50 | 47.00 | ..... | ..... | 65.00 | 70.00 | 12.25 | 14.95 |
| | *42.50* | *42.50* | *40.00* | *40.00* | *40.00* | *42.50* | *42.00* | *45.00* | *45.00* | ..... | ..... | ..... | ..... |
| Los Angeles *a* | *40.00* | *40.00* | *39.00* | *39.00* | *36.00* | *36.00* | *43.00* | *48.00* | *43.00* | ..... | ..... | 9.35gh | 11.35gh |
| Minneapolis ‡b | 40.00[3] | 40.00[3] | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 12.05 | 14.70 |
| ‡ | *42.00* | *42.00* | *42.00* | *40.00* | *40.00* | *42.00* | *44.50* | *53.50* | *53.50* | ..... | ..... | ..... | ..... |
| Montreal [7] | *56.00* | *58.00* | *56.00* | *58.00* | *40.00* | 46.00 | ..... | ..... | ..... | 155.00 | 165.00 | ..... | ..... |
| | *53.50* | *53.50* | *54.25* | *54.25* | *59.25* | *59.25* | *65.00* | *65.00* | *65.00* | ..... | ..... | ..... | ..... |
| New Orleans | 24.00 | 25.00 | 25.00 | 24.00 | 24.00 | 25.00 | 46.00 | ..... | ..... | 62.00 | 69.00 | 13.90 | 16.95 |
| | *29.00* | *29.00* | *32.00* | *33.00* | *35.00* | *34.00* | *36.00* | ..... | ..... | ..... | ..... | ..... | ..... |
| New York ‡ | 48.00 | 49.00 | 45.00 | 45.00 | 46.00 | 48.00 | 50.00 | ..... | ..... | 85.00*f* | 90.00*f* | 17.35g | 21.15g |
| ‡ | ..... | ..... | *52.00* | *52.00* | *53.00* | *52.00* | *54.00* | *54.00* | *54.00* | ..... | ..... | ..... | ..... |
| Philadelphia | 24.00 | 24.50 | 25.50 | 25.50 | 27.50 | 27.50 | 29.00 | ..... | ..... | 50.00 | 57.50 | 17.35g | .1512g |
| | *35.00* | *36.50* | *39.00* | *38.25* | *39.00* | *39.00* | *44.00* | *52.00* | *52.00* | ..... | ..... | ..... | ..... |
| Pittsburgh | 50.80 | 53.20 | 62.75 | 55.00 | 60.85 | 62.50 | 76.25 | ..... | ..... | ..... | ..... | 17.00 | 20.70 |
| | *69.20* | *68.10* | *66.10* | *65.30* | *65.20* | *65.65* | *88.75* | *88.75* | *88.75* | ..... | ..... | ..... | ..... |
| St. Louis ‡c | 44.00 | 45.00 | 41.00 | 40.00 | 40.00 | 42.00 | 52.00 | *58.00* | *58.00* | 75.00 | 74.00 | 13.90 | 16.95 |
| San Francisco *d* | *28.00* | *27.00* | *28.00* | *29.50* | *29.00* | *29.50* | *29.50* | *28.00* | *28.00* | ..... | ..... | 7.30g | 8.90g |
| Seattle | *27.00* | *27.00* | *27.00* | *27.00* | *27.00* | *27.00* | *36.00* | *36.00* | *36.00* | ..... | ..... | 0.00 | 0.00 |

**Bold Face type, Southern Pine.** *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $81.60; on 3/4", $89.90; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *Many mills out of market due to rush of defense orders. *g* Lower rate by water shipment. *h* 50,000 lb. minimum

## GLASS, EXPLOSIVES, CHEMICALS

| | WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality | B quality | EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots* |
|---|---|---|---|
| Atlanta | 75% | 75% | $0.15 |
| Baltimore | 82% | 81% | .15 |
| Birmingham | 75% | 75% | .105 |
| Boston | 80% | 81% | .15 |
| Chicago | 79% | 79% | .15 |
| Cincinnati | 77% | 77% | .15 |
| Cleveland | 79–10–10% | 79–10–10% | .19 |
| Dallas | 78% | 78% | .1625 |
| Denver | 77% | 77% | .155*e* |
| Detroit | 79–10% | 79–10% | .15 |
| Kansas City | 77–10% | 77–10% | .155 |
| Los Angeles | 86%*d* | 88%*d* | .1575 |
| Minneapolis | 76% | 76% | .155 |
| Montreal | 40–10% | 50–5% | .155† |
| New Orleans | 70% | 75% | .16 |
| New York | 81% | 82% | .22*f* |
| Philadelphia | 82–10%*d* | 83–10%*d* | .15 |
| Pittsburgh | 79% | 79% | .1225 |
| St. Louis | 77–10% | 77–10% | .155 |
| San Francisco | 78%*d* | 83%*d* | .155 |
| Seattle | 85%*d* | 88%*d* | .1575† |

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

*a* Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

**40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)**

| | C/L 20,000 lb. net | Tons | 200 lb. lots |
|---|---|---|---|
| E. of the Miss., except Fla | $0.105 | $0.14 | $0.16 |
| W. of Miss. to Rocky Mtn. States, and Fla | .11 –.1175 | .135 –.1475 | .155 –.1675 |
| Rocky Mtn. States | .105 –.1325 | .125 –.1375‡ | .135–.1525‡ |
| Pacific N. W. States | .1075–.12 | .1375–.15 | .1575–.17 |
| Pacific S. W. States | .1050–.1175 | .135 –.1475 | .155 –.1625 |

‡F.o.b. Louviers, Colo., or Butte, Mont.

## PILES, TIES—F.O.B.

### PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

| Dimensions | Points | Length | Short Barge | Leaf Rail |
|---|---|---|---|---|
| 12 in. at butt | 6 in. | 30 to 50 ft. | $0.18 | $0.195 |
| 12 in.— 2 ft. from butt | 6 in. | 50 to 59 ft. | .225 | .24 |
| 12 in.— 2 ft. from butt | 6 in. | 60 to 69 ft. | .23 | .255 |
| 14 in.— 2 ft. from butt | 6 in. | 50 to 69 ft. | .24 | .265 |
| 14 in.— 2 ft. from butt | 6 in. | 70 to 79 ft. | .28 | .275 |
| 14 in.— 2 ft. from butt | 5 in. | 80 to 85 ft. | .40 | .415 |
| 14 in.— 2 ft. from butt | 5 in. | 85 to 89 ft. | .42 | .482 |

### RAILWAY TIES

| Prices f.o.b., per tie for carload lots: | | 6"x8"x8' Untr. | 6"x8"x8' Tr. | 7"x9"x8'6" Untr. | 7"x9"x8'6" Tr. |
|---|---|---|---|---|---|
| Boston | Oak | $1.20 | .... | $1.65 | .... |
| | Pine | 1.50 | $2.25*a* | 2.25 | $3.20*a* |
| New York | S. L. Sap Pine | 1.20/1.30 | 1.95 | 1.60 | 2.45 |
| | Mixed Oak | 1.55 | 2.05 | 2.00 | 2.55 |
| Birmingham | White Oak | .85 | 1.50*a* | 1.35 | 1.70*a* |
| | Southern Pine | .55*b* | 1.10*ab* | .70 | 1.30*a* |
| Chicago | Oak | .... | 1.65*a* | .... | 2.25*a* |
| | Southern Pine | .... | 1.53*a* | .... | 2.13*a* |
| Los Angeles | Douglas Fir | .64 | 1.38*a* | .90 | 1.80*a* |
| Philadelphia | Red Oak | 1.10 | .... | .... | 2.40*a* |
| St. Louis | White Oak | 1.20 | .... | 1.60 | .... |
| | Red Oak | 1.20 | 1.65*a* | 1.60 | 2.20*a* |
| | Sap Pine or Cypress | 1.10 | .... | 1.50 | .... |
| San Francisco | Douglas Fir | 1.00*bef* | .... | .... | 2.45*acf* |
| Montreal | Birch or Maple | .65 | 1.05*a* | .75 | 1.35*a* |

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

### CHEMICALS

**Water, sewage treatment, road work, f.o.b. carlots, New York**

| | |
|---|---|
| Bleaching powder, in drums, f.o.b. works, per 100-lb | $2.00–2.85 |
| Chlorine cylinders, liquid, per lb. delivered | .0525 |
| Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton | 20.50–35.00 |
| Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb | 1.40 |
| Soda ash, 58%, in paper bags, per 100 lb. dense | 1.10 |
| Sulphate of aluminum, commercial, in 100-lb. bags, per ton | 23.00 |
| Sulphate of copper, in bbl., per 100-lb | 4.75 |

# A BOTTLE NECK BREAKER FOR AMERICA'S DEFENSE

Highway, dam, bridge and tunnel contracts being let or under construction for America's defense all call for high speed. Rock removal—the job that often seems to "hang-on" longest; in other words, the bottle neck—is speeded up and broken up with TIMKEN Rock Bits, thereby helping you beat the deadline to the draw.

## *Here are a few reasons why:*

1. TIMKEN Bits sink more hole because TIMKEN Steel (All TIMKEN Bits are made of this material) will stay sharp longer, retain gauge longer.
2. Their streamlined design incorporating a *flush* union on steel and bit results in less stuck steel and reduces steel fracture.
3. Their shoulder construction, whereby the shoulder takes the shock, assures easy removability.
4. Less steel is needed at the drilling site as compared with forged bits, thereby eliminating congestion—especially advantageous in tunneling.

**TIMKEN**
*ROCK BITS*

All these advantages result in faster drilling—always important in the construction game and today still more important because of our defense emergency. Try TIMKEN Bits, you will be convinced—and pleased. Write for further information.

**THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO**

## STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

| | STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in. | 4x12x12 in. | 8x12x12 in. | STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in. | 10x12x12 in. | 12x12x12 in. | BRICK Per M. in quantity. Common backing | Straight hard | LIME Per ton, Hydrated finishing | In paper, Common hydrated | Carload lot, Pulverized or lump |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $90.00 | $100.00 | $185.00 | $220.00 | $230.00 | $240.00 | $12.50 | $17.00 | $26.50 | $17.00 | $17.00 |
| Baltimore | 75.00 | 80.00 | 150.00 | 180.00 | 225.00 | 280.00 | 14.00*k* | 17.00*k* | 18.50 | 15.00 | 2.50*m* |
| Birmingham | 80.00 | 85.00 | 160.00 | 191.00 | 252.00 | 288.00 | 13.50 | 16.50 | 18.11 | 12.64 | 1.60*o* |
| Boston | 82.10*a* | 87.60*a* | 164.20*a* | 186.10 | 243.20*a* | 277.90*a* | 17.00*i* | 20.00*i* | 17.50 | 12.91 | 16.50*l* |
| Chicago | 68.10 | 72.60 | 135.90 | 185.70 | 234.90 | 268.10 | 11.00 | 12.00 | 16.40 | 14.40 | 12.20 |
| Cincinnati | 61.40 | 65.30 | 121.90 | 141.50 | 187.30 | 215.20 | 16.00 | 16.00 | 15.90 | 13.50 | ..... |
| Cleveland | 56.50 | 60.00 | 112.50 | 135.00 | 182.00 | 209.00 | 16.00 | 16.00 | 15.00*j* | 12.00*j* | 2.75*jm* |
| Dallas | 62.50 | 67.00 | 135.00 | 162.00 | 177.00 | 263.00 | 11.50*i* | 13.50*i* | 19.00 | 15.00 | .95*n* |
| Denver | 84.80 | 94.40 | 152.70 | 178.20 | 212.00 | 227.90 | 13.50 | 17.00 | 30.00*j* | 19.00*j* | 30.00*j* |
| Detroit | 69.00 | 73.60 | 138.00 | 176.00 | 232.00 | 265.00*e* | 16.00 | 17.00 | 16.00 | 13.75 | 14.75 |
| Kansas City | 64.50 | 66.50 | 86.00*c* | 125.50 | 159.75 | 186.25 | 14.50 | 24.00 | 19.10 | 12.80 | 10.70 |
| Los Angeles | 73.50†*r* | 89.50†*r* | 128.00*c*†*r* | 210.00†*r* | 368.00†*r* | 460.00†*r* | 13.50 | 15.00 | 16.50 | ..... | 17.50 |
| Minneapolis | 71.45 | 76.20 | 143.95 | 171.45 | 173.80 | 242.10 | 13.10 | 15.10*g* | 21.00 | 16.00 | 19.00 |
| Montreal | 72.20*a* | 77.50*a* | 142.50*a* | 76.00*at* | 165.80*a* | 248.70 | 17.50† | 24.25† | 23.50 | 17.00 | 12.00 |
| New Orleans | 72.00 | 72.00 | 135.00 | 162.00 | 210.00 | 260.00 | 14.00 | ..... | 18.30 | 12.08 | 14.10 |
| New York | 87.00 | 93.00 | 128.00*c* | 193.30*h* | 238.80*h* | 295.60*h* | 13.00 | ..... | 19.00 | 14.00 | 17.00 |
| Philadelphia | 80.50 | 85.90 | 161.10 | 193.30 | 238.80 | 295.60 | 15.50*s* | 18.00*s* | 15.50*q* | 9.55*q* | 12.05*q* |
| Pittsburgh | 58.40 | 62.40 | 116.85 | 124.00 | 153.00 | 193.75 | 17.00 | 25.00 | 17.90 | 15.40 | 2.55*m* |
| St. Louis | 62.00 | 88.00 | 120.00 | 180.00 | 234.00 | 280.00 | 16.00 | 17.00 | 22.00 | 16.00 | 2.30*m* |
| San Francisco | 84.00 | 94.50 | 225.00 | ..... | ..... | ..... | 14.00 | 17.00 | .55*o* | .40*o* | 2.05*m* |
| Seattle | 100.00 | 110.00 | 220.00 | ..... | ..... | ..... | 17.50*f* | 17.50*f* | 20.00*s* | 20.00*s* | 20.00*s* |

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50*a* per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

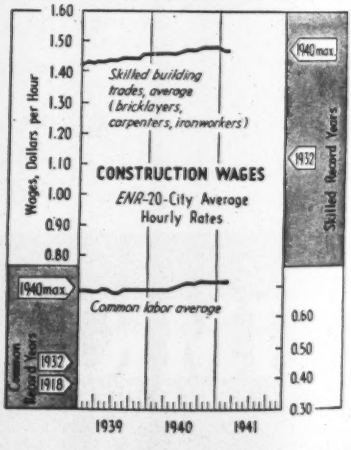
## PAINT, ROOFING—F.O.B. CARLOAD LOTS

| | RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a* | WHITE LEAD Per 100 lb. in oil | READY-MIXED PAINT Per gal., drums Graphite *b* | Aluminum *c* | Ferric Oxide *d* | ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85-90 lb. per sq. | Asphalt felt, per 100 lb. | Tar felt, per 100 lb. | Asphalt coating per gal. | Tar pitch 350 lb. bbl. per ton |
|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $9.25 | $13.125 | $1.30 | $2.25 | $1.20 | $1.90 | $1.61 | $1.61 | $0.27 | $29.00 |
| Baltimore | 9.00 | 12.75 | 1.75 | 2.50 | 2.00 | 2.50 | 3.00 | 3.00 | .60 | 29.00 |
| Birmingham | 9.25 | 13.125 | 2.35 | 2.75 | 1.85 | 1.98 | 1.57 | 1.57 | .32 | 27.00 |
| Boston | 9.00 | 12.75 | 1.85‡ | 2.50‡ | 1.80‡ | 1.96‡ | 1.85*h*‡ | 1.85*h*‡ | .50‡ | 20.00‡ |
| Chicago | 9.00 | 12.75 | 2.10 | 2.63 | 1.72 | 1.45*h*/*f* | 1.50*h*/*f* | 1.50*h*/*f* | .26/*f* | 22.00/*f* |
| Cincinnati | 9.00 | 12.75 | 1.65 | 2.85 | 1.55 | 2.40 | 2.39*h* | 2.39*h* | .36 | 21.00 |
| Cleveland | 9.00 | 12.75 | 1.90 | 2.60 | 1.60 | 1.75 | 1.50*h* | 1.50*h* | .35 | 21.00 |
| Dallas | 9.00 | 13.50 | 1.88 | 2.11 | .... | 2.50*h* | 2.60*h* | 2.70*h* | .50 | 34.00 |
| Denver | 9.50 | 13.25 | 1.65 | 2.40 | .17*l* | 2.45 | 4.00 | 3.00 | .35 | 28.00 |
| Detroit | 9.00 | 12.75 | 1.75 | 2.75 | 1.25 | 2.40 | 2.50 | 2.50 | .35 | 26.00 |
| Kansas City | 9.00 | 12.875 | 2.15*g* | 2.40*g* | 1.67*g* | 1.93 | 2.09 | 2.09 | .25 | 25.00 |
| Los Angeles | 9.25 | 13.25 | 1.60 | 2.25 | 2.30 | 2.10 | 1.50 | .... | .45 | ..... |
| Minneapolis | 9.00 | 12.875 | .... | .... | .... | 1.75*i* | 1.50*h*/*i* | 1.50*h*/*i* | .29 | 21.00 |
| Montreal | 9.25 | 9.00 | 2.40 | 2.97 | 2.51 | 2.64 | 1.85 | 1.86 | .63 | 1.85*k* |
| New York | 9.00 | 12.75 | 2.02 | 2.55 | 1.64 | 1.75 | 1.50*h* | 1.50*h* | .23 | 24.00 |
| Philadelphia | 9.00 | 12.75 | .... | .... | .... | 1.92*e* | 1.99*he* | 1.99*he* | .41*e* | 21.00 |
| Pittsburgh | 9.00 | 12.75 | 1.05 | 1.95 | .80 | 1.95 | 1.94*h* | 1.94*h* | .34 | 26.00 |
| St. Louis | 9.00 | 12.75 | 1.90/2.00 | 2.60/2.80 | 1.60/2.00 | 1.75 | 1.50 | 1.50 | .20 | 21.00 |
| San Francisco | 9.25 | 13.00 | 1.80 | 2.75 | 1.10/2.00 | 1.65 | 2.26 | 2.26 | .28 | 17.00 |
| Seattle | 9.25 | 13.25 | 1.80 | 2.60 | .... | 1.81 | 1.30/2.00 | 1.75 | .35 | 28.00/*j* |

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb.

## SKILLED AND COMMON WAGE RATES—PER HOUR

| | Bricklayers | Carpenters | Struct. Iron Workers | Hoisting Engineers | Plasterers | Common Labor Building | Common Labor Heavy Const. |
|---|---|---|---|---|---|---|---|
| Atlanta | $1.25 | $1.00 | $1.375 | $1.00/1.25 | $1.25 | $0.40/.50 | $0.40/.50 |
| Baltimore | 1.50 | 1.25 | 1.65 | 1.50 | 1.375 | .625 | .625 |
| Birmingham | 1.50 | 1.125 | 1.375 | 1.125 | 1.00 | .40 | .40 |
| Boston | 1.50 | 1.25 | 1.50 | 1.625 | 1.625 | .60/.85 | .60/.85 |
| Chicago | 1.70 | 1.625 | 1.70 | 1.70 | 1.70 | 1.025 | 1.025 |
| Cincinnati | 1.625 | 1.45 | 1.55 | 1.375/1.525 | 1.625 | .75 | .75 |
| Cleveland | 1.625 | 1.375 | 1.50 | 1.50/1.75 | 1.625 | .90 | .90 |
| Dallas | 1.50 | 1.00 | 1.25 | 1.00 | 1.50 | .40/.50 | .40/.50 |
| Denver | 1.65*b* | 1.43*b* | 1.43*b* | 1.43*b* | 1.50*b* | .718*b* | .718*b* |
| Detroit | 1.50 | 1.25 | 1.625 | 1.50 | 1.55 | .60/.75 | .60/.775 |
| Kansas City | 1.625 | 1.375 | 1.50 | 1.50 | 1.575 | .85 | .50 |
| Los Angeles | 1.25 | 1.10 | 1.375 | 1.375 | 1.50 | .625 | .625 |
| Minneapolis | 1.375 | 1.25*d* | 1.50 | 1.40 | 1.50*e* | .85 | .85 |
| New Orleans | 1.50 | 1.25 | 1.375 | 1.375 | 1.40 | .40 | .50 |
| New York | 2.00*b* | 1.85*b* | 2.00 | 2.00*b* | 2.00*c* | 1.031 | .875/.95 |
| Philadelphia | 1.65*b* | 1.40 | 1.65 | 1.50 | 1.75 | .70 | .70 |
| Pittsburgh | 1.75 | 1.50 | 1.50 | 1.25 | 1.75 | .80 | .70 |
| St. Louis | 1.50 | 1.00/1.50 | 1.75 | 1.50/2.00 | 1.75 | .45/.875 | .875 |
| San Francisco | 1.75*c* | 1.25 | 1.60 | 1.50 | 1.60*c* | .813 | .85/.875 |
| Seattle | 1.60 | 1.25 | 1.50 | 1.50 | 1.60 | .90 | .90 |
| Montreal | .80 | .70 | .75 | .65 | .80 | .45 | .40 |




*b* 7 hr. day. *c* 6 hr. day *d* 35 hr. wk. *e* 30 hr. wk.

**ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.470**
**ENR Common Average: $0.713**

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*To meet the needs of the National Defense Program, plus the normal demands of peace, a vast expansion of our already greatly increased production capacity is being speeded. When the emergency is past, there will be more Aluminum available than ever before.*

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Seasonal variation of sewage flow makes it possible for this sewage treatment plant to shut down a number of their aeration tanks during the winter months. This enables them to remove diffuser plates from those tanks, recondition them, and start up again in the spring with every plate working at top efficiency.

Burger Diffuser Plate Holders make this task of removing and replacing plates an easy one. Simply by loosening the holding-down bolts on each plate, that plate can be lifted off. In the spring, it is put back in place and quickly made air- and water-tight against its long-lived rubber gasket.

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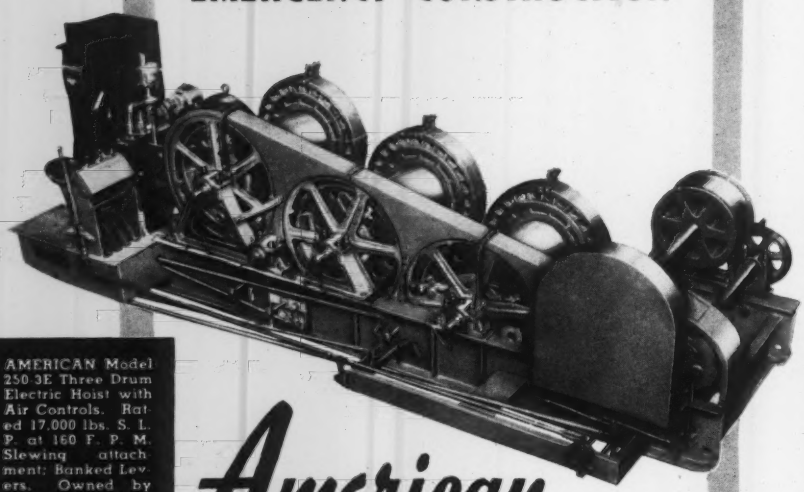

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## MEN AND JOBS

J. H. WILSON, civil engineer, has been appointed electrical superintendent in the Caie Comeau plant of the Quebec North Shore Paper Co. He graduated from the University of Manitoba in 1925 in electrical engineering. Mr. Wilson has had many years experience in the design and operation of power plants in Canada and the United States.

W. G. KNOX has joined the Pacific Employers Insurance Co., Los Angeles, Cal., as representative on the John Martin Dam project. Mr. Knox was active in general engineering practice in southern California for a number of years and was at one time associated with the Metropolitan Water District of Southern California. He was also engaged on work at the Conchas Dam in New Mexico.

MAJ. H. A. MONTGOMERY, chief of the army engineering headquarters at Tulsa, has established headquarters at Oklahoma City to begin work on the new army bombardment squadron base.

LIEUT. COL. CLINTON W. BALL of the Albany, N. Y. office, U. S. Engineers, was honored at a dinner on Dec. 21 by his office associates. He has been transferred to Rock Island, Ill.

The following engineers from the Los Angeles County, Calif. surveyor's department, are now engaged in the national defense program: J. F. ARMSTRONG, street lighting engineer, who holds the rank of captain in the artillery, is stationed at Fort Bliss; DAVID W. BROWN, assistant to Mr. Armstrong, is on active duty with the U.S. Navy engineering staff at Terminal Island, Calif.; HARRY C. GLENN, surveyor's street assessment division, is stationed with the Army Air Corps at March Field and holds the rank of first lieutenant; T. J. STEVENSON, survey party chief, and FRANK C. WOODS, senior draftsman, are now with Allison & Allison, architects, in charge of all survey and mapping work on the army hospital at Santa Barbara, Calif.

MAJ. VIVIAN N. SCOTT, who has served on the staff of the Los Angeles City Engineer since the termination of World War, has been appointed to an executive post in the Army Air Corps with headquarters at Sacramento, Calif.

The Selection Board, Civil Engineer Corps, U. S. Navy, has promoted the following men captains: HENRY F. BRUNS, Navy Yard, Pearl Harbor; JOHN T. MATTHEWS, San Diego, Calif.; PAUL J. SEARLES, Navy Yard, Boston; BEN MORREEL, Chief of Bureau of Yards and

Docks, Washington; CARL A. TREXEL, Bureau of Yards and Docks, Des Moines; ALDEN K. FOGG, Navy Yard, Norfolk, Va.; RALPH E. THOMAS, Navy Yard, Bremerton, Wash.; EDWARD SEIBERT, Naval Air Station, Alameda, Calif.; WILLIAM HENRY SMITH, Navy Yard, New York; EDWARD L. MARSHALL, Bureau of Yards & Docks, Boston; JOHN G. MANNING, Bureau of Yards and Docks, Troy, N. Y.; WILLIAM M. ANGUS, Navy Yard, Charleston, S. C.; LEWIS B. COMBS, Bureau of Yards and Docks, Rensselaer, N.Y.

MAJ. RICHARDSON SELEE, district army engineer at Fort Peck, has been appointed coordinator for development work at the Great Falls, Mont. airport. He will have charge of improvements at several other Montana airport projects.

CAPT. PAUL MINNIEAR of the Illinois State Division of Highways has been called to active service in the army and is now stationed at Cornell University as a military instructor. Mr. Minniear was with the Illinois department for 11 years. MAJ. MAURICE G. PETER has been called into active service in the army and is now in command of the Second Squadron of the 106th Cavalry located in Louisiana. He had been with the Illinois division of highways since May 1922.

JOHN L. FRAZIER, superintendent of construction for the Angostura Dam for the Mexican Irrigation Commission, has resigned his position effective Feb. 1. Mr. Frazier will enter the services of the Ambursen Engineering Corp. of New York City.

A. S. PORTER, chief assistant to Cuyahoga County Engineer JOHN O. McWILLIAMS, has been ordered to active service with the U. S. Navy at Norfolk, Va. Mr. Porter is a member of the civil engineering corps of the U. S. Naval Reserves.

W. A. COSTELLO has been appointed Whatcom County road engineer at Bellingham, Wash. Mr. Costello succeeds P. T. WILTSE, who recently resigned. Mr. Costello appointed GEORGE BROWN as field engineer and DUKE ROTHWELL as WPA engineer.

CLEO HENRIOT has been named district maintenance supervisor for the Washington State Highway Depatment, with headquarters at Hoquiam.

DONALD R. COMSTOCK, division engineer of the Montana State Highway Department at Livingston, has resigned his position to accept an engineering appointment at Coco Solo, Panama.

CHARLES R. BOWERS of Brookings, S. D., has been named district airport engineer for the Civil Aeronautics Authority at St. Paul. He succeeds WILLIAM TODD, JR., who has been transferred to Washington.

J. S. MOORE, after 32 years of service with the Bureau of Reclamation, has been appointed supervisor of soil and moisture conservation on the bureau's projects in the western United States. He has been serving as superintendent of the Yakima project. Mr. Moore was graduated from the engineering school at Washington and Lee College in 1908. D. E. Ball, associate engineer, will be advanced to the position of acting engineer for the Yakima project.

STEPHEN A. DEMING, city engineer for Columbia, Mo., has resigned to take up duty in the Panama Canal Zone as assistant engineer in structural department.

S. L. HOYLE, senior office engineer, North Carolina State Highway and Public Works Commission, has resigned to accept position with the Harwood-Beebe Engineering Co., Spartanburg, S. C.

EDWARD M. DENBO, lieutenant commander in the Civil Engineer Corps, U. S. Naval Reserves, has been called to active duty in the Bureau of Yards and Docks, Washington. Mr. Denbo is a graduate of Purdue University and has been with Indiana Bell Telephone since 1929.

DICK FISHER, of New Philadelphia, Ohio, and engineer in charge of maintenance for the Ohio State Highway Department, has been called into Army service by the U. S. Engineers. Mr. Fisher, who holds a first lieutenant commission, has been ordered to report for active duty at Fort Belvidere.

LIEUT. JULE C. TATE, Civil Engineering Corps, U. S. Naval Reserves, St. Joseph, Mo., has been ordered to active duty at the naval training station at Great Lakes, Ill.

DARRELL N. BLAKE has been re-named Pottawattamie County engineer at Council Bluffs, Iowa. Mr. Blake has held this position since 1937.

LLOYD A. WOODWARD, county engineer, Beatrice, Neb., has resigned to become an assistant in the state WPA engineer's office. He has served as county engineer for the past three years. Mr. Woodward was formerly WPA district engineer for southeastern Nebraska.

A. A. WALKER, former resident engineer at Sherman for the Texas State Highway Department, has re-established his office in that city to make preliminary studies on the relocation of Highway 75, from Sherman to Denison, Tex. He has been stationed in Bonham, Tex. Richard Anderson, who has been assisting Mr.

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EXTRA HEAVY, for the toughest, heaviest jobs;

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- Wet process industries
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**WOLMANIZED LUMBER**


Walker, will be associated with him at Sherman.

Among the recent changes in engineering personnel of the TVA are the following: LAWRENCE H. KORNMAN, associate civil engineer, project planning division, has resigned to accept a position with Stone & Webster; ARTHUR M. BARNES, senior materials inspector, has accepted a position with the Baldwin Locomotive Works, Eddystone, Pa.; GEORGE W. CUMBUS, associate structural engineer, project design division, has joined J. E. Sirrine & Co., Greeneville, S. C.; RAYMOND F. COLGROVE, junior structural engineer, project design division, has accepted an appointment with the Panama Canal Service; HARMON H. GNUSE, JR., has resigned to enter private business; and FREDERICK H. DORNEMANN, construction plant division, will hereafter be associated with the Panama Canal Service.

Recent transfers from the Rock Island, Ill., district office, U. S. Engineers, include the following: JOHN ALLEN, senior draftsman, PHILIP D. FOLEY, subsurveyman, and CURTIS H. FULLER, subsurveyman, all to Seattle, Wash.; DAVID M. MACDONALD, assistant draftsman, to Galveston, Tex.; EDWARD R. O'NEIL, draftsman, to Seattle; and EDWARD A. PERSEN, surveyman, to Galveston, Tex.

R. S. GUINN and W. T. COX of the bridge division, Texas State Highway Department, and J. NEILS THOMPSON and CHESTER MCDOWELL of the materials and tests division, have been granted leaves of absence to serve as instructors for the special engineering defense training courses at the University of Texas.

MAJ. M. E. TOWNES, of Omaha, Neb., has been made construction quartermaster by the War Department of the zone which includes Minnesota, North Dakota, South Dakota, Iowa, Nebraska, Wyoming, Kansas, Missouri and Arkansas.

WALTER E. KROENING, director of service and village engineer, Greendale, Wis. has become village manager, replacing S. L. REEDER, who is to be in charge of federal defense housing at San Diego, Calif. Mr. Kroening went to the Greendale project in 1935 from the Milwaukee Sewage Commission to design and install a sewage plant.

RALPH WHANNEL, formerly field manager for R. B. Slippy Engineering Corp., consultants of Waterloo, Iowa, late in January began new work with the U. S. Engineers in the Canal Zone. Mr. Whannel, junior engineer, will be stationed at Diablo Heights and employed

(*Continued on p. 152*)

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Rolled Alloy Steel
EXCAVATORS
AVE CONCLUSIVELY PROVED THAT
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P&H's modern design of rolled alloy steels was introduced 1500 excavators ago! . . . *fifteen hundred* machines that have been handling everything from soft loam to cemented gravel and rock. Is it any wonder that the trend of profit-wise contractors is toward P&H?

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# CONTRACT UNIT PRICES

**What contractors are bidding on different kinds of construction work**

## ROADSIDE IMPROVEMENT KENTUCKY

OWNER: Kentucky Department of Highways, Frankfort; M. H. Linehan, Jr., Maysville, engr.

PROJECT: Roadside improvement of approaches to overpass of Chesapeake and Ohio Railroad, Maysville, Ky. Includes all planting, trench excavation, and topsoil borrow, necessary for work.

CONDITIONS: Most of transportation will be from contractor's nursery to job by truck. Rail, highway and water transportation facilities available if needed. Contractor to furnish all material and complete work by April 30, 1941. Wage rates stipulated are: skilled, $1.00 per hr.; semi-skilled, 60 to 75c.; common, 40c.

BIDS: Five bids were opened December 13, 1940, ranging from the contract low of $3,758 to $4,844.

LIST OF BIDDERS:

1. Robert Gwinn, Danville, Ky. (contract) ..... $3,758
2. H. C. Adams, Lexington, Ky. ..... 4,288
3. A. Wood Hardin, Louisville, Ky. ..... 4,409
4. Louisville Nurseries, Louisville, Ky. ..... 4,530
5. Lola R. Starnes, Hillsboro, Ind. ..... 4,844

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Blue grass sod | 4,915 s. y. | $0.25 | $0.25 | $0.20 |
| 2. Halls honeysuckle, int. | 1,660 ea. | .10 | .10 | .14 |
| 3. Wichurian rose, 2-year | 62 ea. | .30 | .35 | .24 |
| 4. Redbud, 7-9-ft. | 23 ea. | 1.00 | 1.50 | 2.00 |
| 5. Weeping willow, 1½-in. | 38 ea. | 2.00 | 2.00 | 1.80 |
| 6. Shining sumac, 4 to 5-ft., B & B | 28 ea. | 3.00 | 2.00 | 1.00 |
| 7. Schwedler maple, 2-in., B & B | 14 ea. | 5.00 | 6.00 | 7.00 |
| 8. Pink dogwood, 4 to 5-ft., B & B | 7 ea. | 3.00 | 4.00 | 3.00 |
| 9. White dogwood, 4 to 5-ft., B & B | 7 ea. | 1.50 | 3.00 | 2.00 |
| 10. Sweet gum, 2-in., B & B | 4 ea. | 5.00 | 4.00 | 8.00 |
| 11. Winged Euonymus, 4 to 5-ft., B & B. | 4 ea. | 3.00 | 3.00 | 1.00 |
| 12. Virginal mock orange, 4 to 5-ft., B & B. | 3 ea. | 2.00 | 2.50 | 1.00 |
| 13. Korean Lespedeza seed | 57 lb. | .10 | .25 | .15 |
| 14. Agricultural limestone | 9.5 ton | 3.00 | 5.00 | 8.00 |
| 15. Fertilizer (4–12–8) | 795 lb. | .05 | .05 | .03 |
| 16. Trench and shoulder excav. | 448 c. y. | .50 | .50 | 1.00 |
| 17. Top soil borrow | 448 c. y. | .50 | .75 | .90 |
| 18. Metal guard plate | 1,500 l. f. | 1.00 | 1.25 | 1.27 |

## SEWERAGE SYSTEM, CALIFORNIA

OWNER: City of Tulelake, Calif.; E. K. Hussey, Oakland, engr.

PROJECT: Construction of sanitary sewerage system, pumping station, sewage treatment plant, vitrified sewer, and wood stave pipe force main.

CONDITIONS: Rail and highway transportation facilities available. Contractor to furnish all materials and complete work in 120 days. Wage rates are: skilled labor, $1.00 to $1.25 per hr.; semi-skilled, 62½c.; and common, 50c. per hr. Work to commence Nov. 20, 1940.

BIDS: Two bids were received, the contract low, $42,289, and $44,974.

LIST OF BIDDERS:

1. Manuel Smith, Oakland, Calif. (contract) ..... $42,289
2. Clifford A. Dunn, Klamath Falls, Ore. ..... 44,974

| Item | Quan. | Unit Prices (1) | (2) |
|---|---|---|---|
| 1. 6-in. vitrified pipe | 9,996 l. f. | $0.972 | $1.00 |
| 2. 8-in. vitrified pipe | 1,506 l. f. | 1.35 | 1.20 |
| 3. 10-in. vitrified pipe | 1,105 l. f. | 1.89 | 1.50 |
| 4. 6-in. cast iron pipe | 430 l. f. | 1.35 | 2.00 |
| 5. 10-in. cast iron pipe | 85 l. f. | 2.16 | 3.00 |
| 6. Lampholes | 9 ea. | 21.60 | 26.00 |
| 7. Drop manholes | 9 ea. | 81.00 | 100.00 |
| 8. Standard manholes | 13 ea. | 70.20 | 90.00 |
| 9. 6 x 4-in. vitrified wyes | 255 ea. | .81 | 2.20 |
| 10. 8 x 6-in. vitrified wyes | 28 ea. | .972 | 3.20 |
| 11. Sewage pump station, complete | L.S. | 8,100.00 | 8,577.00 |
| 12. 7-in. wood stave force main, (3,620 l. f.) | L.S. | 4,017.60 | 3,978.00 |
| 13. Sewage treatment plant | L.S. | 11,340.00 | 13,389.00 |
| 14. Extra excavation | 1,000 c. y. | .54 | .50 |
| 15. Imported borrow fill | 1,000 c. y. | 1.62 | 1.00 |

## LEVEE, PENNSYLVANIA

OWNER: U. S. Engineer Office, Baltimore, Md.

PROJECT: Construction of flood control Levee—Unit No. 1—along Susquehanna River and Lycoming Creek in the city of Williamsport, Pa. and vicinity. Involves two sections of "I" wall of steel sheet piling and concrete and two sections of steel sheet piling cut-off wall; six sections of earth fill levee with stone protection on slopes where required; railroad embankment and roadway ramps over earth fill levee; five relief culverts; and alterations to pipe lines and construction of drain interceptor.

CONDITIONS: Contractor to furnish all materials and complete work in one year. Highway and railroad transportation facilities available. Wage rates stipulated are: skilled labor, $1.00 to $1.50 per hr.; semi-skilled, 60 to 85c.; and common, 50c. per hr.

BIDS: Fourteen bids were opened November 7, 1940, ranging from the contract low of $408,477 to $677,936. Engineer's estimate $501,829.

LIST OF BIDDERS:

1. David W. Johnson, Inc., Newark, N. J. (contract) ..... $408,477
2. Frederick L. Cranford, Inc., and Union Constr. & Engr. Co., Inc., Brooklyn, N. Y., and Elizabeth, N. J. ..... 446,989
3. S. J. Groves & Sons Co., Ridgefield, N. J. ..... 452,421
4. The Hinman Bros. Constr. Co., Pittsburgh, Pa. ..... 466,352
5. John Arborio, Inc., Poughkeepsie, N. Y. ..... 475,355
6. John F. Bloomer, Appleton, Wis. ..... 505,866
7. J. T. McCarthy Co., Davenport, Iowa ..... 527,421
8. E. J. Albrecht Co., Chicago, Ill. ..... 538,055
9. Central Pennsylvania Quarry Stripping & Constr. Co., Hazleton, Pa. ..... 560,772
10. Frank Mashuda Co., Milwaukee, Wis. ..... 586,137
11. Harrison Constr. Co., Pittsburgh, Pa. ..... 596,704
12. Hendrickson Bro., Inc., and Joseph L. Sigretto & Sons, Inc., Valley Stream, N. Y., and New York, N. Y. ..... 602,842
13. Arthur A. Johnson Corp., and Necaro Co., Inc., Long Island City, N. Y. ..... 642,916
14. Santaniello Bros., Jersey City, N. J. ..... 677,936

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Diversion and care of water | L.S. | $7,250.00 | $10,000.00 | $5,000.00 |
| 2. Remove exist. struct.; clear site | L.S. | 10,000.00 | 18,500.00 | 20,000.00 |
| 3. Excav.; borrow areas 1, 2, 4, 5, 7 | 610,000 c. y. | .265 | .33 | .30 |
| 4. Excav., borrow areas 3 and 6 | 110,000 c. y. | .265 | .35 | .33 |
| 5. Stripping | 64,000 c. y. | .245 | .12 | .40 |
| 6. Structure excavation | 55,000 c. y. | .245 | .22 | .40 |
| 7. Backfill | 1,300 c. y. | 1.00 | 1.00 | .40 |
| 8. Levee fill; impervious | 457,000 c. y. | .08 | .07 | .06 |
| 9. Levee fill; pervious | 220,000 c. y. | .08 | .07 | .06 |
| 10. Rolling addl. trips | 90,000 sq. | .005 | .02 | .02 |
| 11. Miscellaneous fill | 18,600 c. y. | .25 | .10 | .15 |
| 12. Steel sheet piling, type A | 18,800 s. f. | 1.10 | 1.00 | 1.13 |
| 13. Steel sheet piling, type B | 13,200 s. f. | 1.20 | 1.10 | 1.28 |
| 14. Riprap and rock gutters | 2,500 c. y. | 4.75 | 5.00 | 2.50 |
| 15. Crushed stone backing and filters | 1,260 c. y. | 2.25 | 2.00 | 2.50 |
| 16. Concrete | 1,000 c. y. | 18.00 | 18.00 | 20.00 |
| 17. Reinforcing steel | 78,000 lb. | .055 | .05 | .06 |
| 18. Topsoil | 55,000 c. y. | .45 | .40 | .50 |
| 19. Seeding | 35 ac. | 110.00 | 200.00 | 165.00 |
| 20. 24 in. corr. iron pipe | 186 l. f. | 8.00 | 6.00 | 8.00 |
| 21. 30 in. corr. iron pipe | 120 l. f. | 11.00 | 8.00 | 9.00 |
| 22. 48 in. corr. iron pipe | 266 l. f. | 16.25 | 13.00 | 18.00 |
| 23. Corr. iron seep rings for 24 in. pipe | 4 ea. | 50.00 | 40.00 | 50.00 |
| 24. Corr. iron seep rings for 30 in. pipe | 2 ea. | 50.00 | 50.00 | 60.00 |
| 25. Corr. iron seep rings for 48 in. pipe | 4 ea. | 100.00 | 75.00 | 90.00 |
| 26. Automatic flood gates, 24 in. | 2 ea. | 50.00 | 125.00 | 100.00 |
| 27. Automatic flood gates, 30 in. | 1 ea. | 80.00 | 175.00 | 125.00 |
| 28. Automatic flood gates, 48 in. | 2 ea. | 200.00 | 200.00 | 325.00 |
| 29. 8 in. flap valves | 2 ea. | 30.00 | 75.00 | 60.00 |
| 30. 12 in. flap valves | 1 ea. | 46.63 | 100.00 | 75.00 |
| 31. 16 in. flap valves | 1 ea. | 75.00 | 150.00 | 90.00 |

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